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# The Biology of the North American Crane Flies (Tipulidæ Diptera) III. *The Genus Ula* Haliday

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## INTRODUCTION

The genus *Ula* was erected by Haliday (Entomological Magazine, Vol. 1, p. 153, 1833) for the species *mollissima,* nov., which is now recognized as being the same as the *Limnobia macroptera* of Macquart (Recueil Soc. Sc. Agricult., Lille, p. 158, 1826).

The genus includes six described species, *macroptera* Macquart, the genotype, *sororcula* Zetterstedt, and *bolitophila* Loew, of Europe; *elegans* Osten Sacken and *paupera* Osten Sacken of the United States; and *javanica* Alexander of Java. The series of North American material that I have had for study render it probable that *paupera* Osten Sacken (Mon. Dipt. N. Am., vol. 4, pp. 277, 278, 1869) is the same species as *elegans* Osten Sacken (l. c., pp. 276, 277). The insect varies greatly in its body coloration and in the intensity of the pattern on the wings. It seems possible, moreover, that the three European species are merely variations of a single species, but this question cannot be decided at this time.

Osten Sacken in 1859 (Proc. Acad. Nat. Sci. Phila., p. 199) placed this genus in the tribe *Pedicini* (as *Pediciæformia*) and in 1869 (Mon. Dipt. N. Am., vol. 4, p. 274 to 278) still retained it in this tribe (as *Amalopina*). It has been left in this tribe by all subsequent workers, but the study of the immature stages shows that the reference is quite erroneous. The genus *Ula* should be placed in the *Limnophilini* close to *Ulomorpha* Osten Sacken. The characters of the *Pedicini* (*i. e.,* larva with the anterior margin of the submental region transverse, the caudal end of the body with but two lobes; pupa with the spiracles short, the tips expanded and

* Contribution from the Limnological Laboratory of the Department of Entomology in Cornell University.

truncated) are quite lacking in *Ula,* the larva possessing five lobes around the stigmal field, the mouth-parts similar to those of *Limnophila,* the pupa essentially *Limnophiline,* etc.

Stannius (Beitr. zur Entomol., vol. 1, p. 205, 1826) was the first to give us any information on the immature stages of any member of this genus. He states that the larva of *Ula macroptera* (as *pilosa* Schummel) lives in species of *Agaricus,* and remarks that the larva is very similar to that of *Limnobia xanthoptera* Meigen.

Perris (Note pour servir a l'histoire de la *Cylindrotoma macroptera* Macquart, in Notes pour servir a l'histoire des metamorphoses de diverses especes de Dipteres; Ann. Soc. Ent. France, vol. 7, pp. 337 to 341, 1849) gives a brief description and unsatisfactory figures of this same species. He describes the caudal end of the body as having but four lobes, two being lateral and two ventral; no mention is made of the median dorsal lobe, and it may have been overlooked or it may be very reduced in this species; the caudal or inner aspect of these lobes that surround the stigmal field are provided with small chitinized pieces which, as the author suggests, may serve as points of attachment for the muscular fibres. His account in part may be translated as follows: The fungus in which the larvæ were found was *Hydnum erinaceum* Bull., which grows on the trunks of living oak-trees. The larvæ are gregarious and frequent galleries in the fungus along which they progress by means of their mandibles, which move transversely to their bodies, by their ambulatory feet, by their short hairs and the lobes of the last segment. They were found in the month of November in the Mont-de-Marsan, and a month later they were going into the earth where they transformed as pupæ. These latter quite resemble the pupæ of *Limnophila,* having the same structure, same size, the same hooks, differing only in the color, which is uniformly testaceous, though the breathing horns, instead of being very recurved, are scarcely sinuous. When the time of the last metamorphosis has come, that is about in the months of February and March, the nymph raises itself by means of the spines, comes to the surface of the earth and places itself in position; soon the head and thorax split longitudinally, and it is by this movement that the adult escapes, leaving the exuvia of the nymph fixed in the earth.

In his original description of *Ula bolitophila* (Beschr. Eur. Dipt., vol. 1, pp. 4, 5, 1869) Loew remarks that some of the material upon which the species was based was from Krain, Austria, where it was bred from larvæ dwelling in a fungus on beech trees.

On September 15, 1912, at Gloversville, Fulton County, New York, I took a fleshy species of *Fomes* (*Polyporus*) growing on a stump near the earth. This contained about 35 larvæ of *Limnobia cinctipes* Say, and many larvæ of *Ula elegans* Osten Sacken. The larvæ of these crane-flies infested the upper layers of the fungus and had reduced the surface to a semi-liquid state. At the end of a week the whole mushroom was decayed and semi-liquid. The record of proceedings as it appears in my field-notes is as follows:

"Sept. 28, 1912, at Ithaca, N. Y. The specimens were placed in jars containing sand, which took up the liquids produced by the disintegration of the mushroom and provided a place for pupation.

"Oct. 4, 1912. All of the above larvæ when examined were found to be alive and active.

"Oct. 14, 1912. Four *Ula* emerged today. This limits the pupal period to not longer than ten days."

The insects continued to emerge in large numbers until the 27th of October, when the remaining pupæ were killed and preserved in alcohol. At this time they were very dark-colored and evidently nearly ready to emerge as adults. The larval movements may be described as follows: At each movement forward the terminal segment of the larva partly telescopes into the subterminal and is thrown back violently at each forward movement. At other times the larval motions are very actively to-and-fro, eel-like. The associates of *Ula* in the fungus were larvæ of *Limnobia cinctipes* Say, and a much lesser number of *Limnobia triocellata* Osten Sacken.

After transforming to the adult condition, the pupal skins are found attached to the sand by the apical one-half or the extreme caudal end of the body, often standing up perpendicularly to the surface, the exuviæ being very conspicuous.

The adult flies are most common in the spring and fall, but are rarely if ever taken during the season of midsummer. They are especially numerous in cool, shaded gorges and ravines, and may be swept from beds of low vegetation, such as ferns, ground-hemlock

(*Taxus canadensis*), etc. The following records taken from my distribution sheets indicate the geographic and seasonal range of the species. *Maine:* Fort Kent, Aroostook Co., August 17-19, 1910 (Johnson); August 28, 1913 (Osborn). Orono, Penobscot Co., June 6, 1913 (Alexander). *New Hampshire:* White Mountains, July, 1863 (Osten Sacken's type of *elegans*). *New York:* Old Forge, Herkimer Co., August, 1905, at trap-lanterns (Needham). Pinnacle Mountain, altitude 2000 feet, September 16, 1911; Woodworth's Lake, altitude 1660 feet, August 22, 1910; Johnstown, altitude 600 feet, May 13, 1914; these stations in Fulton Co., collected by the author. Bear Creek, Freeville, Tompkins Co., May 29, 1913; Renwick Flats, May 8 to 14, 1912; Coy Glen, April 27, 1912; these stations in Tompkins Co., collected by the author. *New Jersey:* West Orange, Waverly, Forest Hill, May; Hemlock Falls, August; this material collected by Weidt, in the collection of Dr. Dietz. *District of Columbia:* Washington (Osten Sacken's type of *paupera*). *Virginia:* Fairfax Co., Rosslyn, August 25, 1912 (Knab and Malloch). *Wisconsin:* Price Co., August 13, 1897 (part of the W. M. Wheeler collection in the American Museum).

The following observations upon the mating habits are given: May 14, 1912. At Renwick, Ithaca, N. Y., this species was swarming about 4:30 P. M.; many were "in cop" on the leaves of skunk-cabbage, *Symplocarpus fœtidus*. There were about 15 or 20 individuals in a swarm, which takes place about a foot above the skunk-cabbage leaves. Copulation is rather firm and they fly for short distances still united. In copulation they usually rest on the upper surface of the leaves with all the legs on the support. Swarms were noted consisting of from 1 to 20 individuals, and usually from 6 to 12 inches above the leaves. At this time the only adult crane-fly found with *Ula* was *Limnophila ultima* Osten Sacken, which occurred in small numbers.

## DESCRIPTION OF THE IMMATURE STAGES

ULA ELEGANS Osten Sacken.

*Ula elegans* Osten Sacken. Monographs of the Diptera of North America, part IV, pp. 276, 277, 1869.

### LARVA

(Plate I, Fig. 2)

Length: Maximum, 8.5-11.9 mm.; diameter, 1.4-1.8 mm.

Color of the larva dull white, the head-capsule very dark brownish black, shiny. The caudal end of the body is produced into five blunt teeth of which the dorsal one is median in position, two lateral teeth slightly above the plane of the body, and two ventral teeth directed laterad; the dorsal tooth is more blunt than the others. The inner or caudal face of each tooth is adorned with a conspicuous brownish black mark; the mark of the lateral tooth (see Plate I, Fig. 3) is large, its outer end conforming with the shape of the teeth, rounded at the tip, inner end concave, not touching the stigmata, separated from the stigma by a space about equal to the light brown outer portion of the spiracle. Ventral teeth with the black mark shaped as follows: Elongate, the dorsal outer face gently convex, the inner ventral face gently convex on the terminal portion, concave near the dorsal end; its dorsal or inner end is separated from the spiracle of the same side by a distance a little less than the diameter of the spiracle. Dorsal tooth with the mark small, elongate-oval. A fringe of delicate blackish hairs around the caudal end on the outside of the black marks and running inward between the teeth; these hairs are longer and more prominent at the ends of the teeth. Stigmata almost round, very widely separated from one another, the space between being about three times the diameter of a single spiracle. Interstigmal disk pale with an indistinct mark shaped as in the figure.

Head-capsule rather oval. Antennæ (see Plate I, Fig. 5) inserted on the sides of the front, just laterad of the caudal margin of the clypeo-frontal sclerite; basal segment rather short, cylindrical, more widened at its base, the tip with two small conical lobes that are almost transparent. Clypeo-frontal sclerite (see Plate I, Fig. 7) broad at the base, the cephalic margin broadly rounded,

with a small rounded protuberance on the anterior margin, widely separated from one another, this being the anterior end of the epipharynx underneath; the sclerite is yellow with a broad band across the middle and a second one across the caudal margin; the middle band indicates the position of the epipharynx beneath (see Plate I, Fig. 8). Maxilla large, the outer lobe conspicuous, enlarged cylindrical with a small knob at the tip. Mandibles (see Plate I, Fig. 6) long and slender with a long, strong apical point and from three to four smaller lateral teeth on the inner face near the tip, these teeth gradually smaller from the tip toward the base and thus presenting a somewhat comb-like appearance. Submental region (see Plate I, Fig. 4) moderately well-developed, the median split behind quite deep; the cephalic margin with subequal teeth arranged regularly, four on either side, and a much smaller apical tooth occupying the terminal notch.

## Pupa

(Plate I, Fig. 1)

Male. Head viewed from beneath: Mouth parts not prominent. Maxillæ appearing as two lobes, contiguous on the median line of the body, the palpi very long, extending laterad underneath the eye to the antennæ. Labium small, in the shape of a caudal lobe behind the maxillæ. No spines on the front, but there are several dark lines on the space between the eyes that have the appearance of long appressed hairs, the tips directed backward. Antennæ not prominent, rather widely separated at the base, ending just before the origin of the wing-pad. A small bilobed protuberance shows between the antennal bases.

Thorax with the pronotal breathing horns directed cephalad and laterad, rather pointed. Thoracic dorsum without lobes or spines. Tips of the metatarsi about on a common level, the fore pair of legs ending slightly beyond the tips of the other two pairs. Legs long, extending about midlength of the fifth abdominal segment. Wing-pad ending just beyond the tip of the first abdominal segment.

Abdominal tergites with transverse rows of scattered setigerous punctures, which rows are fairly well defined on the anterior segments, especially on the first segment, where there are some 20 to

25 in a row. Beginning on the second tergite, there is a broad transverse band of subchitinized, shagreened texture; on the second to fourth segments they are subbasal, but the last two are on the ends of the segments, one on the fourth, the last on the fifth. The fifth and sixth tergites have the setigerous punctures quite abundant and scattered, except on the basal third, which is bare. The seventh segment bears four obtuse indistinct lobes, two on either side of the median line. The eighth tergite is rounded, with a deep median notch. The eighth sternite shows the genitalia within, consisting of lobes that bear from 12 to 15 strong chitinized points on the inner caudal face. The four basal sternites are hidden by the elongate leg-pads; the sixth with a sub-basal ring of the shagreened appearance described above, the abdomen beyond this ring is provided with numerous scattered hairs, in front of it without hairs.

Mouth parts, wings and legs, rather dark brown. The thoracic dorsum and abdomen are rather light yellowish brown. The pronotal breathing horns are very conspicuous, dark brown basally, passing into a bright light yellow on the apical third or quarter. The mesonotal præscutum retains its light coloration even in old pupæ and those preserved in alcohol.

Length: Total, 6.4-7 mm.

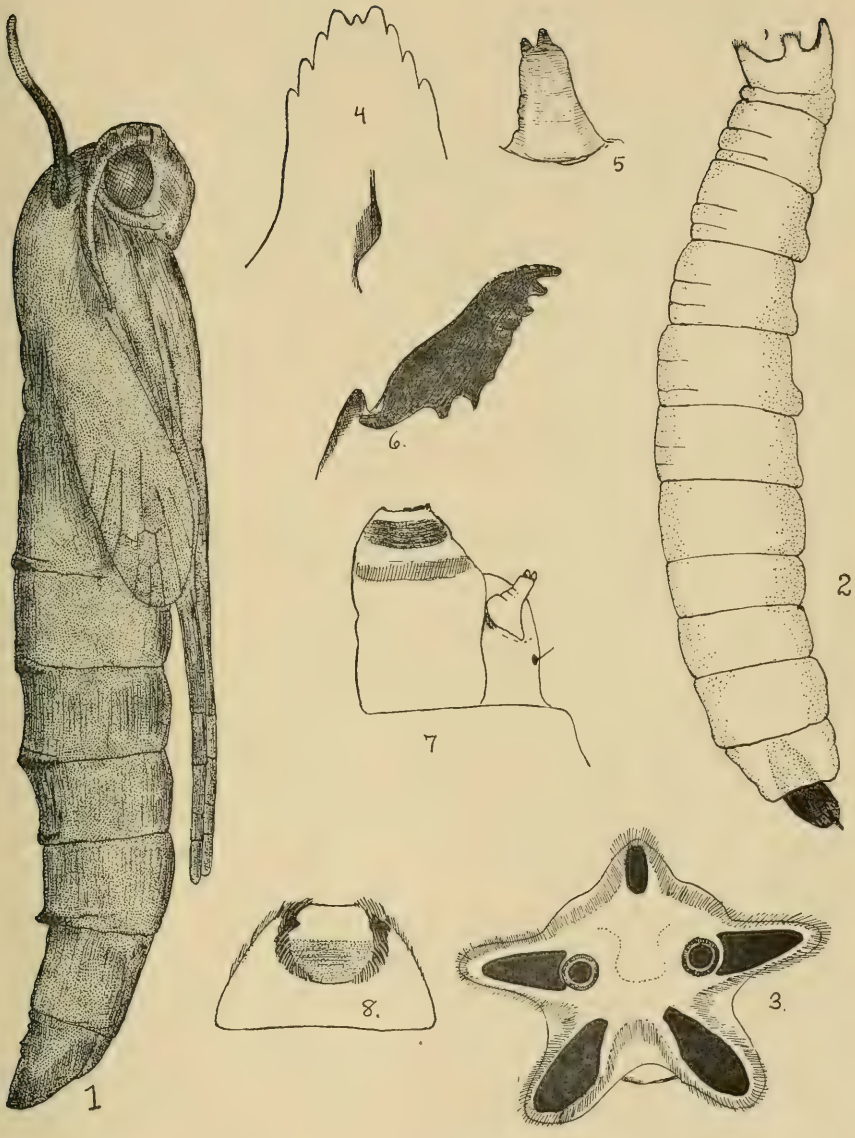
Dextro-sinistral width at the wing-pad: 1.2-1.3 mm.

Dorso-ventral depth at the wing-pad: 1.2-1.6 mm.

Larva and pupa described from material preserved at Ithaca, N. Y., on October 15, 1912.

## EXPLANATION OF THE PLATE

Figure 1. Pupa, lateral aspect.
Figure 2. Larva, lateral aspect.
Figure 3. Larva, caudal end of abdomen, caudal aspect.
Figure 4. Larva, submental region, ventral aspect.
Figure 5. Larva, antenna, dorsal aspect.
Figure 6. Larva, mandible, ventral aspect.
Figure 7. Larva, clypeo-frontal region, dorsal aspect, showing the antenna.
Figure 8. Larva, clypeo-labral region, ventral aspect showing the epipharynx.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# The West Coast Species of Pedilus Fisch. (*Corphyra* Say)

H. C. FALL

I have in this essay used the generic name *Pedilus* in place of the long established *Corphyra* of Say, in deference to the opinion of Mr. Champion, as expressed in the "Biologia," although I have had no opportunity of personally verifying his conclusions. The differences in ventral formation of *Pedilus* and *Corphyra,* as originally stated by Du Val, and cited by Horn in his first Synopsis—Trans. Am. Ent. Soc., 1871, p. 278,—if correctly represented, would appear to be amply sufficient for their separation, but there is probably some misapprehension here.

It is a little remarkable that with all the collecting done within the bounds of California prior to the arrival of the " '49ers," no species of this genus were made known by either Eschscholtz, Mannerheim or Motschulsky, although several are more or less abundant in the vicinity of San Francisco. It was left for Le Conte, in 1851, to describe the first species (*punctulatus*) from this region, and in his synopsis of the genus in 1855 this was the only one known from the West Coast. Two more—*vittatus* and *funebris*—were described by Horn in 1871, and on working up the extensive material brought back from the Coast by G. R. Crotch in 1873, six more species were added by the same author. At this time Horn presented a table for the separation of the West Coast species, and remarked that "the number from the Pacific region now equals that from the entire region east of the Rocky Mountains." The last paper that has appeared on the genus is a short review of all the species of our fauna by Dr. Horn in 1883, in which one new Californian form—*flabellatus*—is made known. Of the ten described forms, *funebris* and *distinguendus* prove to be only color phases of *punctulatus* and *bardii* respectively, the net result being eight distinct species known to this region up to the present time.

In a recent study of the West Coast material contained in my own collection, supplemented by the greater part of that in the collec-

tions of Dr. Van Dyke, Dr. Blaisdell, Dr. Fenyes, Mr. Nunenmacher and Mr. Hopping, I have detected no less than ten new species—including one from Arizona—thus more than doubling the number hitherto defined, and proving that the *Pedilus* fauna of this Coast is far richer than that of all the rest of the United States combined. Moreover, further collecting may well bring to light additional species in the Pacific region, while the number from east of the Rockies is more likely to be decreased than increased by a new critical study.

The descriptions in the following pages will be found as a rule very brief, embodying little more than those diagnostic characters which have proved of service in comparative study. Throughout the genus there is great uniformity in bodily form, general structure, pubescence, etc., and it is only in the few exceptions to the general rule that these matters have been alluded to at all. As is well known, the sexual characters of the male, both primary and secondary, are very varied and interesting, and it is only by means of them that the species can be readily and satisfactorily identified. In the ♂'s perhaps without exception, the antennæ are more or less noticeably longer and more strongly serrate; the apical margins of the fifth and sixth ventral segments are also more or less sinuate or emarginate in this sex throughout the genus. The special modifications of the elytral apex in the ♂'s of a majority of species, and also the genitalia in this sex, are sufficiently varied to require careful description in each species. The intromittent organ of the ♂ consists of a corneous sheath terminating in two lateral processes of variable form, which are frequently hooked or barbed on their inner margins, and containing the true efferent duct, which is itself corneous, or at least of denser consistency toward the tip, which is more or less acuminate. I have in the accompanying plate illustrated by simple outline sketches the variations in the form of the œdeagus, as well as the chief modifications of the antennæ and claws of the species here treated.

It is not my purpose at this time to speak individually of the species of *Pedilus* inhabiting the Eastern United States. As at present understood, they are easily enough identifiable by means of Horn's latest table; but there is unquestionably room for renewed

study by some one having the necessary material. As pointed out by Mr. Charles Dury in his Cincinnati List, *pulcher* is without doubt merely a variety of *labiatus*. Mr. Dury also suggests that *fulvipes* may be only a yellow legged form of *lugubris,* but this, I think, cannot be possible, as the two have distinctly different male genitalia. Mr. Dury's specimens with pale legs may really be *lugubris,* but the true *fulvipes* should rather be united with *newmani,* as suggested by Blatchley. There is a distinct possibility that the material now passing as *collaris* may involve more than one species; a problem for the future.

As compared with the West Coast species, those of the Eastern United States are not only less numerous, but exhibit far less structural variation. For example: In all the species of the Atlantic region the tarsal claws are similarly broadly, strongly toothed; while in those of the West Coast there are three distinct forms of ungual tooth. In the Eastern species the antennæ are quite uniformly feebly serrate; in the Pacific species the antennæ vary all the way from feebly serrate through strongly serrate to pectinate and flabellate. In the Eastern species the head is always very finely and sparsely punctate; in the Western ones it varies from very finely to quite coarsely and densely punctate. In the Eastern species variations in color are seemingly confined to the legs and prothorax; while in those of the West Coast there is a most pronounced tendency to dichromatism in the color of the elytra in many species, with a lesser amount of variation in the color of legs and prothorax. In all the Eastern species there is a sexual modification of the elytral apex in the male; in the Pacific species this sort of modification exists in greater variety, but is by no means universal, there being a considerable number of species in which it is totally lacking.

I regret that I am unable to say anything concerning the larval habits of the species of *Pedilus*. The beetles themselves are found —sometimes in numbers—on flowers, appearing rather early in Spring—March and April—in the vicinity of the Coast, but considerably later in the season in the Sierras.

## Table of West Coast Species

1. Antennæ flabellate in the ♂, prothorax widest in front of the middle, distinctly narrowed posteriorly. *flabellatus*
   Antennæ pectinate in the ♂, prothorax widest at middle, as usual. *crotchii*
   Antennæ serrate in both sexes. 2.
2. Hind tibiæ of ♂ slightly arcuate, inner side flattened and feebly grooved, tip of elytra not modified in the ♂, claws with large basal tooth.
      Front and middle tarsi of ♂ distinctly dilated. *abnormis*
      Front and middle tarsi of ♂ not appreciably dilated, antennæ a little less strongly serrate, hind tibiæ of ♂ less conspicuously modified. *infectus*
   Hind tibiæ similar in the sexes. 3.
3. Claws in the ♂ with a stout truncate inner lobe or tooth parallel to and nearly as long as the claw itself—shorter and less truncate in the ♀ — extreme tip of elytra in the ♂ impressed and smooth. *longilobus*
   Claws with a large, sharply and somewhat acutely angulate basal tooth, similar in the sexes. 4.
   Claws with a much smaller basal tooth or dilatation, similar in the sexes. 5.
4. Antennæ strongly serrate, longer than half the body *serratus*
   Antennæ feebly serrate, not or scarcely longer than half the body.
      Elytral apex differently colored in ♂, front and middle tarsi distinctly dilated (♂), side pieces of œdeagus straight. *monticola*
      Elytral apex not different in color in the ♂, front and middle tarsi very feebly dilated, side pieces of œdeagus curved. *arizonesis*
5. Tips of elytra in the ♂ either differently colored, smoother, impressed or more widely margined; front and middle tarsi of ♂ more or less dilated, side pieces of œdeagus barbed at tip (except *alticola*).
   Tips of elytra not modified in the ♂. 9.

6. Head beneath more or less closely and coarsely punctate, especially toward the sides; distinctly punctate above. 7.
Head beneath sparsely and finely punctured, very finely and remotely punctate above. 8.

7. Elytra black, the apex in the ♂ yellow, smoother, acutely caudate with the tips reflexed.
Elytra vittate. *bardii*
Elytra not vittate. var. *distinguendus*
Elytra black or rufotestaceous, the apex in the ♂ yellow, smoother, sometimes a little more convex, sometimes not; the tips acute but scarcely produced.
Prothorax rufous. *punctulatus*
Prothorax black. var. *funebris*
Elytra rufotestaceous to black, the apex in the ♂ more widely margined but not otherwise modified. *oregonus*
Elytra yellow, the apex in the ♂ with a strong oblique anteriorly recessed impression which is black and impunctate. *cavatus*

8. Elytra black, the apex in the ♂ strongly obliquely impressed, the flattened tips yellow and impunctate. *flexiventris*
Elytra black, the apex in the ♂ with an elongate oval juxtasutural impression which is somewhat smoother, the tips acute but scarcely produced. *alticola*

9. Elytra not vittate, front and middle tarsi of ♂ not dilated, side pieces of œdeagus not barbed.
Elytra black, prothorax red. *inconspicuus*
Elytra yellow; suture, apex and side margin—at least posteriorly—blackish. var. *flavidus*
Elytra blackish varying to pale brown, prothorax black. *picipennis*
Elytra vittate, front and middle tarsi of ♂ dilated, side pieces of œdeagus barbed internally near the apex.
Prothorax more finely punctured, without fine sharply impressed median line. *vittatus*
Prothorax more coarsely punctured, and with a fine median impressed line of variable length. *lineatus*

*Pedilus flabellatus* Horn

Trans. Am. Ent. Soc. X, 1883, p. 306.

*Length* 4.5-6.5 mm. (teste Horn), 5-5.5 mm. in the material before me.

Black, prothorax and legs reddish yellow, integuments strongly shining.

*Antennæ* piceous, flabellate in the male.

*Head* with a few fine punctures. Eyes distinctly more prominent than the tempora, the latter slightly convergent.

*Prothorax* widest before the middle, narrowed posteriorly, very finely remotely punctate.

*Elytra* finely, not closely, punctate.

*Male:* Antennæ with joints 2 and 3 short, 4-10 branched,, the processes shorter on joints 4-5, but on 6-10 nearly as long as the width of the head across the eyes; joint 11 as long as the five preceding and equal in length to the process of joint 10. Elytra unmodified at apex; tarsi not at all dilated and without squamules beneath.

*Female:* Antennæ normally serrate, the second joint alone small.

A very distinct and isolated species, unique in the structure of the ♂ antennæ and in the form of the prothorax. According to Horn, one ♂ out of six examples seen has the elytra pale.

The type series was from Western Nevada—doubtless from the Eastern slope of the Sierras.

There are before me nine specimens—8 ♂'s, 1 ♀—from the following localities, all in California: Lake Tahoe (Tallac and Tahoe City, taken by Dr. Fenyes and myself respectively); Sugar Pine, Yosemite region (Fenyes); Plumas Co. (Van Dyke Coll.); Mohawk (Fenyes); Castle Crag (Fenyes); Sisson—June (my Coll.); McCloud (Van Dyke).

*Pedilus crotchii* Horn

Trans. Am. Ent. Soc., 1874, p. 41.

*Length* 5 mm. Black, prothorax rufous, elytra yellow or reddish yellow, with the suture and apex narrowly blackish.

*Antennæ* black, subserrate in the female, pectinate from the 3d

joint in the male, the processes subequal in length to the joints themselves.

*Head* and *prothorax* finely and sparsely punctured. *Elytra* closely punctate. Claws with a small basal dilatation.

*Male:* Antennæ pectinate; elytra not at all swollen at tip, but with a small shallow apical impression; front and middle tarsi distinctly dilated; œdeagus nearly as in *abnormis*.

*Female:* Antennæ subserrate, elytra not modified at apex; tarsi not dilated.

Of this species I have seen only the three examples—1 ♂, 2 ♀—in the LeConte collection. The species was described from the ♂ only, taken by Crotch at Crystal Springs, San Mateo Co., California, a few miles south of San Francisco. The two ♀'s were probably added later since in the original description the ♀ is said to be unknown and if this be the case it is quite possible that they are not really *crotchii*. It is a little surprising that with all the collecting done by Drs. Blaisdell and Van Dyke in the vicinity of San Francisco, their collections contain no examples of this species, unless perchance there be some unrecognizable ♀'s. The ♂ may be at once distinguished from all our other known species by the pectinate antennæ, but the ♀ must, I think, be very similar to that of several other species.

*Pedilus abnormis* Horn.

Trans. Am. Ent. Soc., 1874, p. 40.

*Length:* 6¼ to nearly 8 mm. Black, shining, elytra in the ♀ normally more or less pruinose and dull; prothorax typically red, more rarely black.

*Antennæ* rather short and stout, moderately serrate, half as long as the body or slightly more in the ♂, scarcely half as long as the body in the ♀; intermediate joints about ¼ longer than wide.

*Head* parallel behind the eyes; minutely remotely punctulate; tempora and sides beneath sparsely finely punctate.

*Prothorax* sparsely punctate.

*Elytra* closely, rather finely punctate.

*Male:* Elytra more shining than in the ♀, not pruinose, apex not modified. Four anterior tarsi dilated. Hind tibiæ arcuate and

flattened or feebly grooved on the inner side; fourth ventral segment produced in a broad lobe with bisinuately truncate apex; fifth ventral transversely tumid at middle, the apex broadly sinuately emarginate. Side pieces of oedeagus broadly arcuate, not hooked or barbed on the inner margin, the tips rounded; central piece gradually pointed, the tip narrowly rounded.

*Female:* Elytra pruinose; tarsi not dilated; hind tibiæ not distinctly arcuate or flattened; fifth ventral broadly rounded and deflexed at apex.

This is one of the most distinct of the West Coast species and with the exception of the next is quite unique in its tibial and abdominal secondary sexual characters. It is not rare in the higher parts of the Middle Sierras of California, and has been found just across the line in Western Nevada, and also in Northern California, where a race with black thorax occurs in Siskiyou, Shasta and Trinity Counties. In Dr. Fenyes' collection there is a ♂ example, also with black thorax, from the Rocky Mountains of Colorado. Specific localities in the material before me are as follows:

*California:* Tulare Co. (Mineral King 8000 feet and Monarch Lake 10500 feet, August 3rd and 4th, G. R. Pilate; Gray Meadow, July 3 — Hopping): Fresno Co. (Paradise Valley, 7000 feet, July 16—Van Dyke; South Fork, Kings River Canyon, July 4—Van Dyke; Huckleberry Meadow, July 15—Hopping): Eldorado Co. (Strawberry Valley, August 6; McKinney's, July—Van Dyke): Calaveras Co. (Big Trees, July 19—Blaisdell): Lake Tahoe (Tallac and Tahoe City, July—Fenyes): Sierra Co., June 19—Nunenmacher; Mohawk, June 21—Fenyes; Tuolumne Co.; Siskiyou Co.; Shasta Co.; Nash Mine, 5000 feet, Trinity Co.—Van Dyke; Cole, July—Fenyes; Mt. Silliman, 10,000 feet, August 3—Hopping.

*Pedilus infectus* n. sp.

*Length* 5½-5¾ mm. Very close indeed to *abnormis*, but of smaller size, the antennæ somewhat less strongly serrate, the punctuation relatively a little coarser, the front and middle tarsi (♂) not appreciably dilated, the hind tibiæ (♂) similarly but more feebly modified, the lobe of the 4th ventral segment broadly sinu-

ate at apex. In *abnormis* the apex of this lobe is as a rule broadly but noticeably arcuately produced at middle and slightly sinuate each side. The female shows no trace of the pruinose lustre so characteristic of typical *abnormis*.

Described from a single pair (♂ ♀) taken in June in the San Jacinto Mts. in Southern California by J. C. Bridwell and submitted by Dr. Van Dyke.

*Pedilus longilobus* n. sp.

*Length* 7-7.8 mm. Type—Black, basal two joints of antennæ, and prothorax, rufous, the latter with posterior discal darker cloud. Varies to entirely black or with the elytra yellow, with suture, side margin posteriorly and tip, blackish; tibiæ yellowish toward the base.

*Antennæ* rather strongly serrate, scarcely longer than half the body in the male.

*Head* finely sparsely punctate, tempora short, parallel, the hind angles and sides beneath coarsely rugosely punctate.

*Prothorax* finely sparsely punctate, sides as a rule less strongly arcuate than usual.

*Elytra* densely, not coarsely punctate.

*Male:* Extreme tips of elytra flatly impressed; front and middle tarsi moderately dilated; claws with a long lobiform tooth, truncate at tip; side pieces of œdeagus straight, gradually acuminate, feebly incurved at tip and with a broad, rounded angulation on the inner side at some distance from the apex.

*Female:* Apex of elytra unmodified, tarsi not dilated, claws with a shorter, more triangular tooth.

Ten examples (9 ♂'s, 1 ♀) are known to me. The type was collected by Mr. Nunenmacher in Plumas Co., California, June 13. It has been taken by Dr. Fenyes at Tahoe City in June and by Dr. Van Dyke at Nash Mine, 5000 feet, and Carrville, Trinity Co., June 14-16. Two examples from Humptulips, Wash., have been sent me by Dr. Van Dyke.

In appearance and characters *longilobus* is closely allied to *serratus,* the pale form mentioned above being superficially distinguishable from *serratus* only by the shorter and less strongly serrate an-

tennæ. The male genitalia of the two are also virtually identical, but the form of the ungual tooth at once separates them. In the greater number of specimens the sides of the prothorax are less rounded than in any other species, but this character is not always to be depended upon.

*Pedilus serratus* n. sp.

*Length* 6.4-7.8 mm. Black, prothorax, elytra, basal two joints of tne antennæ, and legs, except the femora, yellow or rufotestaceous. A variety is totally black.

*Antennæ* longer than half the body in the male, strongly serrate, the apical edge of the intermediate and outer joints strongly oblique.

*Head* finely, sparsely, evenly punctate; tempora rather short, parallel, coarsely punctate at sides and beneath.

*Prothorax* finely, sparsely punctate, the size and spacing of the punctures nearly as on the head.

*Elytra* closely but not coarsely punctate, pubescence rather conspicuous.

*Male:* Elytra with a small apical subimpunctate blackish area which is broadly, rather flatly impressed; front and middle tarsi feebly dilated; side pieces of œdeagus as in *longilobus*.

*Female:* Unknown.

The apical elytral impression occupies the greater part of the small smooth area and becomes gradually deeper toward the suture and tip. The narrow anterior border of the smooth area above the impression is slightly more convex.

The type is one of three males received from Mr. Nunenmacher, who took them June 11-12 in Eldorado Co., California. One of the three specimens is entirely black.

*Pedilus monticola* Horn

Trans. Am. Ent. Soc., 1874, p. 41.

*Length* 6.5-7 mm. Black, labrum and clypeus—in part, prothorax and tip of elytra in the male, reddish yellow.

*Antennæ* feebly serrate, black, apex of the first joint and the second joint more or less completely pale; barely half as long as the body in the male, still shorter in the female.

*Head* shining, distinctly nearly evenly punctured, the punctures separated by twice their own diameters on the average; tempora parallel, coarsely closely punctate at sides and beneath.

*Prothorax* shining, the punctuation very similar to that of the head.

*Elytra* densely punctate, feebly shining.

*Male:* Elytra each with a bullate and impressed reddish yellow apical area which is confluent with its fellow along the suture, but does not involve the extreme tip; the impression shining and sparsely asperately punctate. Front and middle tarsi moderately dilated; œdeagus narrow, the side pieces slender and straight, their inner edge without sign of hook or angulation.

*Female:* Elytra entirely black, tip not modified; tarsi not dilated.

The form above described does not agree with Horn's original description of *monticola,* but there is a fair probability that it is the black variety mentioned by him in the remarks following the description. As described the original type had yellow elytra, the legs except the tarsi yellow, basal two joints of antennæ piceous (the remaining joints lacking), and in the 1883 synopsis the œdeagus is said to be like that of *lewisii.* In answer to my inquiry, Dr. Skinner writes that there is no type of *monticola* in the Horn collection. In the LeConte collection I found three examples under this name. The first was a yellow ♂ bearing the label *"monticola"* in Horn's handwriting and *should be* the type. It has the antennæ wanting except the basal two joints, but these are pale (not piceous as described) and the œdeagus is entirely different from that of *lewisii.* This specimen bears the simple locality label "Cala" and has no letter indicating precise locality, as was customary in the Crotch material, from which *monticola* was described. The 2nd and 3rd examples in the LeConte series are neither of them like the first nor like each other nor can either of them be *monticola* if the original description is exact. I feel rather confident that the species I have here described is a black form of the first example—bearing Horn's written label—in the LeConte cabinet, but whether the latter is the true type, or whether the type has dis-

appeared and the name label been attached to something else cannot now be answered.

The present species would by Horn's latest table fall near *lewisii,* which it rather closely resembles in a general way, but this latter has the head and prothorax almost impunctate and the œdeagus of an entirely different from. The œdeagus in the present species is very nearly identical with that of *labiatus* in which species, however, the elytral apex in the male is black, the impression deeper and less close to both suture and apex, the thorax vittate and the labrum and clypeus entirely yellow.

There are before me 4 ♂'s, 2 ♀'s taken by Mr. Uunenmacher, June 9-11 in Plumas Co., California. Others collected by Dr. Fenyes at Tahoe City and Tallac, June. Rorn names Calaveras as the type locality of his *monticola,* and later gives as additional localities Nevada and Montana. There is little doubt that he mixed two or more species under this name.

*Pedilus arizonensis* n. sp.

*Length* 5.3-6 mm. Black, antennæ blackish brown, surface moderately shining, sparsely pubescent.

*Antennæ* feebly serrate, slightly longer than half the body in the male.

*Head* very finely and sparsely punctate, tempora parallel, more coarsely punctate at sides and below.

*Prothorax* minutely remotely punctate like the head.

*Elytral* punctuation dense, the punctures of medium size.

*Male:* Elytra each with a small suboval juxta-sutural smooth apical impression; fifth ventral broadly, rather deeply arcuately emarginate; front and middle tarsi a little dilated; side pieces of œdeagus rather strongly arcuate, the tip broad, excurved, with the outer apical angle a little prominent, inner edge with a very slender and acute spine projecting inward at some distance from the apex.

*Female:* Unknown.

The sexual characters of the ♂ are throughout nearly as in *lewisii,* but there is no appreciable swelling at the elytral apex, the impression is relatively a little smaller, the size of the insect is distinctly less and the color totally black.

The type is one of three males from Mt. Lemon, Santa Catalina Mts., Arizona (Coll. Van Dyke). There is little doubt that the black Arizona examples referred to by Horn under *lewisii* belong here.

*Pedilus bardii* Horn.

Trans. Am. Ent. Soc., 1874, p. 42.

*Length* 5-6 mm. Black, prothorax rufous, elytra each with a slightly oblique testaceous vitta from the humerus to near the apex, which is caudate and tipped with yellow in the male.

*Antennæ* entirely black, moderately serrate, a little longer than half the body in the male.

*Head* moderately punctate, the punctures separated on the average by their own diameters or a little more, the hind angles coarsely densely punctate.

*Prothorax* more finely and sparsely punctate than the head.

*Elytra* coarsely, closely punctate.

*Male:* Elytra in about the apical fourth, smooth and shining with fine sparse punctuation, the apical fifth or more yellow, the tips strongly acutely caudate and a little reflexed. Front and middle tarsi slightly dilated; side pieces of œdeagus barbed on the inner edge.

*Female:* Antennæ a little shorter and less strongly serrate as usual; elytral apex not modified; tarsi not dilated.

The type was collected by Crotch at San Buenaventura (Ventura), California. A single female from Santa Barbara is before me.

var. *distinguendus* Horn

Loc. cit., p. 42.

Identical in all respects with *bardii,* except that the elytra are not vittate.

The type was taken by Crotch at the same time and place as *bardii.* This seems to be the normal or at least the more common form of the species, though as yet but few specimens of either are in collections. There are before me 7 ♂'s and 3 ♀'s, all from Santa Barbara (Coll's Blaisdell and Van Dyke), except a pair taken by

the writer at Pomona, April 4, 1892, and a ♂ from Tehachapi in Dr. Fenyes' collection; Horn also gives Visalia.

This is one of our smaller species and is instantly recognizable by the caudate elytra of the male. The females of *bardii* are quite similar in a general way to those of the other vittate species—*vittatus* and *lineatus*—but in these the punctuation of the head and thorax is distinctly denser, and that of the elytra less coarse than in *bardii*. The female of *distinguendus* is identical in appearance and may easily be confused with a number of others, more especially of *flexiventris* and *inconspicuus*, which are of about the same size. From the female of *flexiventris* it may be distinguished by its distinctly more punctate head, but from that of *inconspicuus* there seems to be no certain means of separation.

*Pedilus punctulatus* Lec.

Ann. Lyc. Nat. Hist., N. Y., 1851-52 V, p. 151.

*Length* 5-8 mm. Black, prothorax reddish yellow, occasionally with blackish discal cloud, elytral apex yellow in the male. Varies with the elytra entirely testaceous, or the whole insect except the tip of the elytra in the male may be black (var. *funebris*).

*Antennæ* black, moderately serrate, half the length of the body in the male, a little shorter in the female.

*Head* rather strongly and closely punctate, the punctures separated on the average by their own diameters, a little less close at the middle of the front; tempora densely rugosely punctate at sides.

*Prothorax* quite distinctly punctate, the punctures slightly finer than on the head and distant by about twice their own diameters.

*Elytra* densely moderately coarsely punctate, lustre rather dull, often faintly pruinose.

*Male:* Apex of elytra smoother, finely punctate, and tipped with yellow, the smooth area usually slightly more convex at the summit of the declivity, the sutural angles somewhat acute but not produced; front and middle tarsi distinctly dilated; side pieces of œdeagus barbed internally near the tip.

*Female:* Apex of elytra not modified; tarsi not dilated.

An abundant species in the Bay Region of Middle California, the numerous specimens at hand bearing labels San Francisco, Ala-

meda and Marin Counties, April-June (Coll's Blaisdell and Van Dyke). Other localities represented are Carmel, Monterey Co., May 21 (Van Dyke); Guerneville, Sonoma Co., May 29; Carrville, Trinity Co., June 3-30 (all in Van Dyke Coll.); Lake Co. (Blaisdell and Van Dyke); Ahwahnee, Madera Co. (Fenyes); Seattle, Wash., May 21 and Sept. 1 (Prof. O. B. Johnson).

var. *funebris* Horn

Trans. Am. Ent. Soc., 1871, p. 286.

Entirely black, tip of elytra yellow in the male, otherwise precisely as in *punctulatus*.

Occurs with the typical form about San Francisco Bay and in Monterey Co., specimens at hand bearing the same locality labels as given above.

The rather large size, conspicuously punctate head, and dull elytra, make this species easily recognizable among those occurring in the same region. The form of the elytral apex in the male is characteristic.

*Pedilus oregonus* n. sp.

*Length* 5.9-7.8 mm. Type—Black prothorax rufous. Varies as follows: In three examples (all ♂'s), the tip of the elytra is yellow; in one of these the thorax is black, in the others red, one example is entirely black; in several others the elytra are rufotestaceous with the suture and side margins—especially toward the apex—narrowly to more widely blackish. In one the blackish margin is almost completely wanting and the legs are pale with the distal ends of the thighs blackish.

*Antennæ* entirely black, moderately serrate, half as long as the body in the male, a little shorter in the female.

*Head* unusually closely punctate, the punctures separated by less than their own diameters except at the middle of the front, where they are distant by their own diameters or a little more; tempora parallel, the hind angles coarsely densely punctate.

*Prothorax* finely, rather sparsely punctate.

*Elytra* closely, not coarsely punctate.

*Male:* Apical margin of elytra more widely reflexed but not otherwise modified; front and middle tarsi distinctly dilated; side

pieces of œdeagus nearly straight, barbed internally near the tip.

*Female:* Apex of elytra less widely margined, tarsi not dilated.

The more widely reflexo-explanate apical margin of the elytra in the male without other modification (the pale tips in some examples not being a constant character) distinguishes this species from all others in our fauna. The females may, with care, be distinguished from other species occurring in the same region by the relatively densely punctate head, in which respect it is only surpassed by *vittatus* and *lineatus*.

The type is one of a series of specimens taken by Nunenmacher in Josephine Co., Oregon, June 8-11. Other examples were found by Nunenmacher on the same collecting trip in Siskiyou Co., California, May 31. I have also seen a single ♂ from Cole, Siskiyou Co., California (Fenyes); two examples from "Or" and one each from Cooks, Wash., and White Salmon, Wash., in Prof. O. B. Johnson's collection, and have received a ♂ from Corvallis, Oregon, June 6 (Moznette).

*Pedilus cavatus* n. sp.

*Length* 5.6-7.5 mm. Head and body beneath black, prothorax rufotestaceous, elytra flavotestaceous, the apex blackish in both sexes; legs variable from entirely pale except the knees, to black or piceous with the tarsi and apical parts of the tibiæ paler.

*Antennæ* entirely black, more than half the length of the body in the male, the apices of the joints strongly oblique; less strongly serrate and not longer than half the body in the female.

*Head* minutely sparsely punctate, the hind angles and especially the sides beneath more closely and coarsely so.

*Prothorax* very finely sparsely punctate.

*Elytra* densely, rather finely punctate and with the pubescence longer and denser than usual, the surface lustre in consequence somewhat dull.

*Male:* Apex of each elytron with an abrupt deep oblique terminal impression, which is somewhat recessed anteriorly, the impressed area—except the extreme margins—black, polished and nearly impunctate; fifth ventral segment almost perpendicularly arcuately deflexed, its apex truncate and just perceptibly arcuato-emarginate; front and middle tarsi distinctly dilated; side pieces

of œdeagus nearly straight, a little divergent apically, finely barbed interiorly near the tip; middle piece very slender, gradually finely acuminate with a small dilated or bulbiform tip which is inferiorly hooked when viewed laterally.

*Female:* Elytra unmodified at apex; the fifth ventral deflexed but less strongly so than in the male; tarsi not dilated.

This fine distinct species may be at once recognized by the unusually dense pubescence, combined with the deeply impresso-excavate elytral tips and strongly deflexed fifth ventral segment in the male. One other species only—*flexiventris*—has the same type of impression of the elytral apices, though rather less deep and scarcely recessed, and also has the strongly deflexed fifth ventral, but it differs otherwise in its smaller size different color, coarse elytral punctuation and normally sparse pubescence.

*Cavatus* inhabits California from the vicinity of San Francisco to the northern boundary. The following localities are represented in the 15 examples before me, the majority of which were collected by Dr. Van Dyke; others by Nunenmacher and Blaisdell.

Alameda Co. (type); Contra Costa Co. (Redwood Cañon, May 28); Marin Co. (Fairfax, June 13; Muir Woods, May 14-17); Sonoma Co. (Eldredge, April 14; Sobre Vista, April 30); Trinity Co. (Carrville, June 6-27); Humboldt Co., May 15; Siskiyou Co., June 2.

*Pedilus flexiventris* n. sp.

*Length* 3.8-6 mm. Black, prothorax reddish yellow; elytral apex yellow in the male.

*Antennæ* moderately serrate, longer than half the body in the male, about half the length of the body in the female.

*Head* and prothorax minutely remotely punctate, the hind angles of the former scarcely more closely so.

*Elytra* densely and coarsely punctate.

*Male:* Apices of elytra abruptly compressed, the compressed area entirely yellow, its anterior walls vertical or even slightly inflexed and extending obliquely outward and forward from the suture; fifth ventral segment strongly deflexed; front and middle tarsi a little dilated; side pieces of œdeagus nearly as in *cavatus,* the middle piece similar except that it is not dilated at tip.

*Female:* Apices of elytra not modified; fifth ventral moderately deflexed; tarsi not dilated.

In its sexual modifications, both primary and secondary, this species is obviously allied to *cavatus,* but the differences in size, color, elytral sculpture and pubescence as indicated under the latter mark it as abundantly distinct. So far as known its geographical range lies entirely outside that of *cavatus.*

All specimens seen are from Southern California. The type is a ♂ from Pasadena, collected by Dr. Fenyes. I have taken it at Pomona, May 20; Glendora, July 8, and in the San Bernardino Mts., July. Other examples before me are labeled Sierra Madre, June (Fenyes); San Diego, April 18 and May 10 (Blaisdell).

*Pedilus alticola* n. sp.

*Length* 5.5-7.8 mm. Black, moderately shining, prothorax rufous.

*Antennæ* rather feebly serrate, very little longer than half the body in the male, slightly shorter in the female.

*Head* and prothorax very minutely remotely punctulate.

*Elytra* finely, moderately closely punctate.

*Male:* Elytra each with an apical elongate juxta-sutural impression, which is smooth in its posterior half, the sutural tips acute but not produced; front and middle tarsi feebly dilated; side pieces of œdeagus broadly arcuate on their outer edge toward the apex, the tip gradually pointed and seemingly not barbed on the inner margin.

*Female:* Elytral apex not modified, tarsi not dilated.

In none of the specimens at hand is there any indication of change of color of the elytral apex. This species is, so far as known, confined to the Middle Sierras of California at altitudes of 5000 to 11,000 feet. The type is a male collected at Atwood's Mills, Tulare Co., 6600 feet, June 24, by Mr. G. R. Pilate. A female from "below Monarch Lake," 10,500 feet was also sent by Mr. Pilate. There are also at hand 1 ♂, 2 ♀'s taken at Yosemite, June, by Dr. Fenyes, and several examples taken by Mr. Hopping at Round Meadow, Giant Forest, Tulare Co., July.

*Pedilus inconspicuus* Horn

Trans. Am. Ent. Soc., 1874, p. 42.

*Length* 5-7.5 mm. Black, prothorax rufous.

*Head* only moderately sparsely and not very finely punctate, the tempora at sides and beneath closely coarsely so.

*Prothorax* finely sparsely punctured.

*Elytra* rather densely and coarsely punctate.

*Male:* Elytra unmodified at apex, front and middle tarsi not dilated; side pieces of œdeagus with a sub-apical projecting tongue on the inner edge; middle piece acuminate with finely spiniform tip.

*Female:* Elytra and tarsi not appreciably different from those of the male.

var. *flavidus* n. var.

For the sake of convenience this name is proposed for a form of the above species having the elytra rufotestaceous or yellow with the sutural edge, side margin, at least toward the apex, and the tip blackish. The antennæ and legs are normally entirely black as in the typical form.

If the numerous specimens which I have associated under the name *inconspicuus* really constitute a single species—and of this I am by no means certain— it is unquestionably the most widely distributed and most variable of our West Coast species. In the more than one hundred examples before me, however, the differences exhibited by salient individuals become evanescent, and this together with the fact that the secondary sexual characters—or rather the entire lack of them—as well as the genitalia are apparently identical throughout, has led me to consider them all as representatives of a single species. The form of the œdeagus is peculiar to this species and is not adequately represented by Horn's figure, there being there no indication of the tongue-like projection from the inner margin of the side pieces. The slender front and middle tarsi with entire absence of glandular pubescence is an exceptional character, shared only by *flabellatus* and *picipennis*.

The type series of *inconspicuus* is said by Horn to have been collected by P. S. Sprague of Boston, and though the precise locality is not indicated, there is little doubt they were taken somewhere in

Middle California. The black form occurring in the San Francisco Bay region may therefore, I think, be safely regarded as typical. Along with them, and even more abundant, judging from the material at hand is found the pale form—var. *flavidus*. Farther east, in the foothills of the Sierras, from Tehama to Tulare Co., the *flavidus* form alone prevails, at least there are no black examples from this region in the material examined. Farther to the North—in Siskiyou Co. the black form and a dusky pallescent variety of it occurs, while throughout Southern California the black form alone is found. These Southern California specimens, when compared with those from Middle California, appear as a whole to be smaller with relatively slightly shorter elytra and stouter antennæ. The dusky pallescent male from Siskiyou Co. has the antennæ distinctly shorter than in the typical form, but in a black male occurring with it, this disparity is less obvious.

The following localities are represented in the material before me:

*California:* Santa Clara Co.; Belmont, April; Alameda Co.; Oakland, April 12-26; Mt. Tamalpais, April 28; Muir Woods, Marin Co., April 23-May 17; Lake Co.; Santa Rosa; Siskiyou Co., June 1-4; Tehama Co., April 26; Sacramento Co., April 15; Eldorado Co., June 10; Mokelumne Hill; Kaweah; Ft. Tejon; Santa Barbara Co.; Pasadena, March 9-April 6; Pomona, March 28-June 11; Elsinore.

*Pedilus picipennis* n. sp.

*Length* 5-6.8 mm. Black, typically with the elytra, antennæ, tibiæ and tarsi paler, varying from piceous to pale brown; more rarely almost uniformly black throughout.

*Antennæ* moderately serrate, distinctly longer than half the body in the male.

*Head* finely, sparsely punctate; tempora parallel, coarsely punctate at sides beneath.

*Prothorax* finely sparsely punctate.

*Elytra* rather finely and densely punctate.

*Male:* Elytra completely unmodified at apex; fifth ventral segment more strongly emarginate than usual; front and middle tarsi

not at all dilated; side pieces of œdeagus rather strongly arched, briefly excurved at tip, the latter blunt with the outer angle distinct and a little prominent from a certain viewpoint.

*Female:* Elytra and tarsi as in the male; fifth ventral rounded at apex as usual.

Of the seven examples before me (3 ♂'s, 4 ♀'s) six were taken in July by Dr. Fenyes and the writer at Lake Tahoe (Tahoe City and Deer Park Inn); the seventh example, in Dr. Van Dyke's collection bears label "Bubbs Cr. Cn., Kings River, Fresno Co., Cal. Alt. 9700 feet, July 14, 1910." Since writing the above Dr. Van Dyke has sent me a series of 9 ♀'s taken at McCloud in Siskiyou Co., June 21-July 6.

*Pedilus vittatus* Horn.

Trans. Am. Ent. Soc. 1871, p. 279.

*Length* 5.5-8.8 mm. Piceous, prothorax beneath, and sometimes the margin as seen from above, narrowly pale; elytra each with a testaceous vitta extending from the humerus nearly to the apex, and side margin posteriorly, pale, varying to entirely testaceous; legs rufotestaceous with the knees piceous, varying to entirely piceous except the bases of the femora.

*Antennæ* pale brownish testaceous, occasionally piceous in the darker specimens, moderately serrate, somewhat longer than half the body in the male.

*Head* black, rather densely and coarsely punctate; tempora a little convergent behind.

*Prothorax* less strongly transverse than usual, conspicuously, rather closely punctate, the punctures slightly finer than on the head, frequently with a very narrow median impunctate line.

*Elytra* densely, moderately coarsely punctate.

*Male:* Elytra not modified at apex; front and middle tarsi dilated; side pieces of œdeagus nearly straight externally, internally barbed near the tip.

*Female:* Elytra as in the male; tarsi not dilated.

The vittate elytra with their apices unmodified in the male will separate this species from all others in our fauna except the next *(lineatus)*, from which the tabular characters will serve to dis-

tinguish it. The nonvittate examples which, notwithstanding Horn's remark, seem to be about as often ♂'s as ♀'s, somewhat resemble pale specimens of *picipennis,* but the latter has a sparsely punctured head and the male genitalia very different.

All specimens before me with one or two exceptions are from the vicinity of San Francisco. Most of them were taken by Drs. Blaisdell and Van Dyke and bear labels Muir Woods or Redwood Cañon, Marin Co., April 23-May 17. One example is from Alameda Co., another in Dr. Fenyes' collection is from Point Reyes, Marin Co.; one in Dr. Van Dyke's collection is from Santa Cruz Co., and one from Mr. Hopping was taken at San Joaquin Mill, Tulare Co., April 4.

*Pedilus lineatus* n. sp.

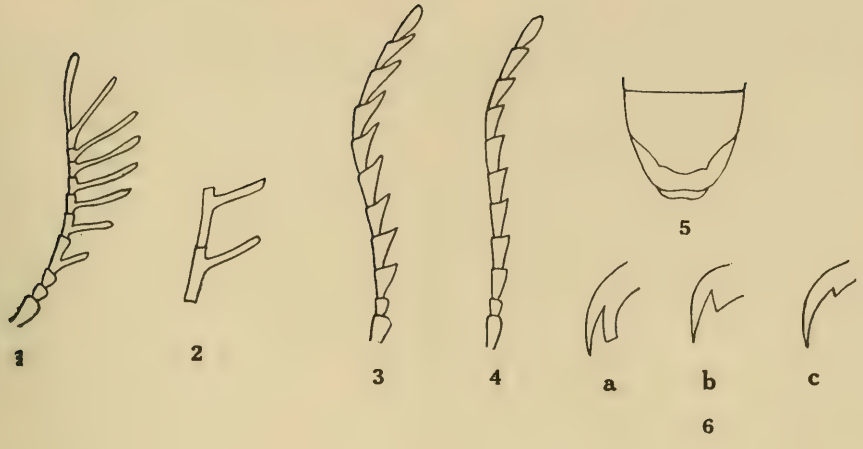
*Length* 5.6-8 mm. Closely similar to *vittatus,* but more coarsely punctate throughout. The head is quite as densely punctate as in *vittatus,* the tempora as a rule a little more noticeably convergent. The prothorax is rufous with a discal darker cloud which is variable in extent; the punctuation though coarser, is rather sparser than in *vittatus,* and there is in every specimen I have seen a very fine median sharply impressed line which attains neither base nor apex and may be quite short. This impressed line is indicated in only one of the twenty-eight examples of *vittatus* before me. The elytra are typically vittate in all examples. The sexual characters are apparently the same as in *vittatus.*

Described from 1 ♂ (type) and 5 ♀'s, all but one of which were taken at Pasadena, Cal., in April and May, by Dr. Fenyes. The remaining specimen bears simply the label "So. Cal." (Van Dyke coll.).

## EXPLANATION OF PLATE

Figure 1. Flabellate antenna (*flabellatus*).
Figure 2. Pectinate antenna (intermediate joints of *crotchii*).
Figure 3. Strongly serrate antenna (*serratus*).
Figure 4. Feebly serrate antenna (*alticola*).
Figure 5. Ventral segments 4-6 of *abnormis*, male.
Figure 6. Types of tarsal claws.
*a.* Claw with long truncate tooth (*longilobus*, male).
*b.* Claw with large, sharply angulate basal tooth (*abnormis; infectus; serratus; monticola; arizonensis*)
*c.* Claw with small basal tooth (*flabellatus; crotchii; bardii; punctulatus*, etc.).
Figure 7. Œdeagus of *flabellatus*, from beneath.
Figure 8. Œdeagus of *abnormis*. (*a*) From above; (*b*) from beneath.
Figure 9. Œdeagus of *serratus*. (*a*) From above; (*b*) from beneath.
Figure 10. Œdeagus of *monticola*, from beneath.
Figure 11. Œdeagus of *bardii*, from beneath.
Figure 12. Œdeagus of *cavatus*, from beneath. (*a*) Lateral view of central piece.
Figure 13. Œdeagus of *alticola*, from beneath.
Figure 14. Œdeagus of *inconspicuus*, from beneath.
Figure 15. Œdeagus of *arizonensis*, from beneath.
Figure 16. Œdeagus of *picipennis*, from beneath.

Figure 8 will also serve very nearly for *infectus*.
Figure 9 will also serve very nearly for *longilobus*.
Figure 11 will also serve very nearly for *punctulatus, oregonus vittatus* and *lineatus*.
Figure 2 will also serve very nearly for *flexiventris*.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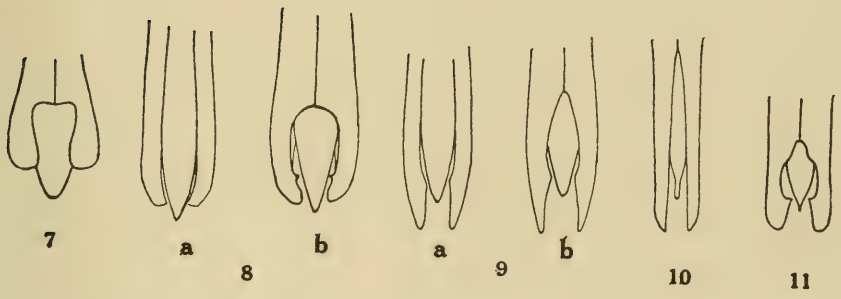
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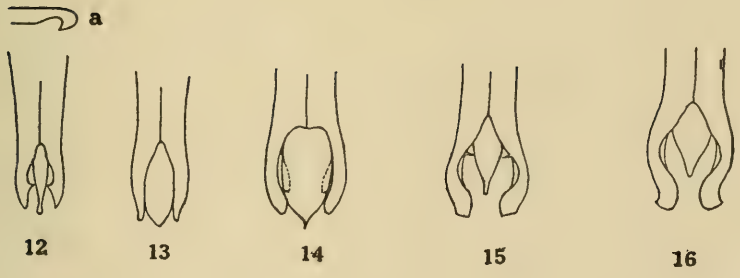
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# The Proventiriculus of a Hydropsyche Larva*

ALICE AYR NOYES

## I. Introduction

The proventriculus has been the object of much study in certain families of the Orthoptera (Locustidæ, Gryllidæ, Blattidæ and Mantidæ), Coleoptera (Dytiscidæ, Carabidæ and Scolytidæ), Hymenoptera (certain Vespidæ and Formicidæ), and Odonata, but comparatively little is known of its structure in the Trichoptera.

While making a study of the food of Hydropsychid larvæ, my attention was called to the remarkably well developed proventriculus. The details of its structure show marked departures from the ordinary type and will be discussed in detail later. I have therefore undertaken a careful study of its structure in the larvæ of certain species of the genus Hydropsyche, and here shall consider it under three heads,—general morphology, histology, and physiology.

This work was done under the direction of Professor William A. Riley, to whom I wish to express my appreciation for his kindly interest and helpful criticism.

The results of this work have been based upon a study of the organ by dissection, and by means of serial sections, both cross and longitudinal. Examinations of the food-content of the proventriculus, as well as of the regions immediately preceding and following it, were made.

In the material sectioned, the larvæ were killed by decapitation, whereupon the anterior part of the alimentary canal shot out and was cut off and placed at once into the fixing fluid. Both Gilson's fluid, and a saturated aqueous solution of corrosive sublimate + 5% glacial acetic acid were used with good results. Some of the material was stained in toto with borax carmine, and some on the slide with Delafield's haematoxylin and eosin. Cedar oil was used as a clearer, and all of the material was embedded in paraffin. The

* Contribution from the Entomological Laboratory of Cornell University.

majority of the sections were cut 10 microns thick, though a few were cut 5 microns.

## II. Morphology of the Proventriculus

A. *External.* The alimentary canal of the Hydropsychid larva is a straight tube. The fore-intestine, which extends to the middle of the metathorax, is divided into the following parts: Pharynx, œsophagus, proventriculus, and the œsophageal valve, which is an invagination of the fore-intestine into the mid-intestine. The proventriculus is the region just before the mid-intestine, and is confined to the meso- and metathoracic segments. (Fig. 1, P. ). When there is little or no food in the canal, this region is clearly defined and is barrel shaped. The coat of circular muscles is very thick and the intima greatly modified. The latter is armed with numerous dark brown teeth, which, unlike those of some of the forms which have been previously studied, are plainly visible through the muscular layers. A series of yellow spines caudad of the teeth, and two valves armed with spines on their outer surface, may also be seen without dissection. (Fig. 1.)

B. *Internal.* On dissecting the proventriculus, it is seen to differ from the forms already described, in the large number of strong teeth, and the presence of two well developed valves in the posterior region of the organ. These valves are connected with the œsophageal valve and, so far as I know, have not been figured in literature before.

The intima of the œsophagus is thrown into six primary folds (Fig. 2, Fd. 1), which become clothed with caudally-directed spines as they near the proventriculus. Each of these folds becomes subdivided caudally into six secondary folds (Fig. 2, Fd. 2) which pass into the teeth of the proventriculus. The thirty-six chitinous teeth are arranged in six groups—five large teeth (Figs. 2 and 3, Tl.) in each group, separated by a smaller lower tooth (Figs. 2 and 3, Ts.). The large teeth viewed from the side are, roughly speaking, triangular in shape. Just caudad of the apex is a sinus, and in many cases the apex itself has a slight concavity. (Fig. 3, Ts.) Caudad of these teeth are typically twelve rows of closely set yellow spines, arranged in parallel lines and directed forward. (Fig. 2, Sp.)

Occasionally there are slight variations as to the number of rows. Slightly cephalad of the point where the fore-intestine meets the mid-intestine, is an invagination of the epithelium with its thickened intima into the lumen, forming two projecting valves which are capable of completely closing it. (Figs. 2, 4, 7, 9, V.) A projection from the wall of the proventriculus (Fig. 7, St.) fits in between the valves and makes the stoppage more complete. The furrow formed between the valves and the wall of the canal is lined practically along its entire extent with forwardly-directed, closely-set spines also arranged in parallel rows. The surface of the valves bordering on the lumen is destitute of spines.

The œsophageal valve (Figs 4, 9, Oe. v.) extends into the mid-intestine for about one-sixth of its length, and is continuous with the two valves which are in front of it. It is very peculiar in that it is not a complete tube, but is open along the entire side where the free ends of the valves approach each other. (Figs. 8, o, 9.) The edges of the œsophageal valve along this opening are thickened and folded and bear many little chitinous tooth-like projections on their surface. (Fig. 9, F.) There is also a narrow circular band of similar teeth (Fig. 9, Cb.) on its outer surface, a short distance from its distal end.

## III. Histology of the Proventriculus

When considered histologically, the proventriculus of Hydropsyche presents some interesting features. These relate especially to the method of formation of the chitin, the epithelial layer underlying the teeth, and the arrangements of the muscular layers.

A cross or longitudinal section taken through this organ shows the following layers, beginning at the lumen and passing outward,—the intima, the epithelium, circular muscles and longitudinal fibres. (Fig. 4, Ch., Ep., Cm., Lm.) Each of these will be discussed in turn.

A. *The Intima.* The intima is a non-cellular layer, which has become heavily chitinized in parts. It is modified to form teeth in the anterior and spines in the posterior region. There are thirty-six teeth which are greatly strengthened by chitin at their apices. When the teeth of Hydropsyche are compared with those figured

by Miall and Denny (1886) for Gryllus, and by Matheson (1912) for Corydalis, they are seen to differ. Instead of being lined with a layer of epithelial cells, each tooth is comparatively solid (Fig. 6, Tl.), and the epithelium only slightly projects into the base of it. (Fig. 6, Ep.) Matheson found the centre of the teeth of Corydalis to be filled with a "supporting tissue" which was non-cellular and considered by him to be a secretory product of the epithelial cells.

Some of my sections showed clearly that the teeth of Hydropsyche are formed partly by a secretion and partly by a transformation of the protoplasm. At first there is a layer of chitin surrounding a process of the underlying epithelial cells which extends up to the apex of each tooth. (Fig. 5, Cy.) Later, the cytoplasm becomes transformed into chitin, leaving the fully formed tooth solid. (Fig. 6.) This supports the view that chitin may be formed by a combination of a secretory product of the epithelium and a transformation of protoplasm, rather than by either of these methods considered alone.

B. *The Epithelium.* The epithelium underlying the teeth presents a wavy outline when seen in cross-section (Fig. 6, Ep.), due to the fact that the cytoplasm extends slightly into the base of each tooth. The nuclei are very prominent and are oval to spherical in shape. Typically, there is one nucleus underlying each tooth, so that they are quite far apart. In a few cases, however, there appear to be two nuclei for a tooth, but this is probably due to the way in which the section was cut.

The epithelium in the posterior part of the proventriculus is flattened, and the nuclei, which are about one-fourth the size of those preceding, are spherical and lie close to one another. (Fig. 4.)

A slight distance in front of the point where the fore-intestine joins the mid-intestine, the epithelium becomes invaginated into the lumen of the canal, forming the two valves above mentioned. These are covered by a very thick chitinous layer. The epithelium is much flattened on the side toward the lumen, but is composed of columnar cells on the side facing the wall of the enteron. (Fig. 4, 7, Ep. col.)

C. *Muscular Tissue.* The usual arrangement of the muscular layers in the fore-intestine of insects is that of an inner layer of longitudinal and an outer layer of circular muscles. The same arrangement is to be found in the case of the walls of the proventriculus of most of the forms figured in the literature on this subject. In the proventriculus of Hydropsyche, however, the reverse is true, and the longitudinal muscles lie outside of the circular coat. (Figs. 4, 6, Lm., Cm.) This same arrangement of muscle layers was also found by Vorheis (1905) in the larva of the caddis-fly, Platyphylax designatus, Walker.

The circular muscle layer is very thick, especially where it underlies the teeth. It gradually diminishes in thickness posteriorly. The layer of longitudinal muscles consists of fibres which are arranged regularly outside of the circular layer. (Fig. 7, Lm. 1.) In the regions opposite the ends of the valves, the fibres unite to form heavier strands which run the length of the proventriculus. (Fig. 7, Lm. 2.)

## IV. Physiology of the Proventriculus

In regard to the function of the proventriculus, there are three differing views: 1. That the proventriculus is a grinding organ ("Kaumagen"), either for the hard chitinous parts of the food or for a further trituration of the softer parts. Some of the leading adherents of this view are Burmeister (1832), Dufour (1841), Basch (1858), Graber (1869), Wilde (1877), Miall and Denny (1886), and Bordas (1896). 2. That it acts as a strainer and insures the gradual passage of food into the mid-intestine. This view has among its supporters, Plateau (1874), Eberli (1892), Packard (1898), and Petrunkewitsch (1900). 3. That it is an organ facilitating the passage of the mid-intestinal secretions into the crop, and by its contractions thoroughly mixing these secretions with the food. This view is the most recent, being supported by Deegener (1910) and Ramme (1913). These men believe that it also has a straining function.

I have made observations on the feeding habits of the Hydropsyche larva and an extended study of the food. The larva takes both animal and vegetable food, but during the period of its

greatest activity—spring and summer—the large bulk of the food is of animal nature. It is composed, for the most part, of May-fly nymphs (Heptagenia), Chironomid and Simulium larvæ. The remainder of the year, diatoms and filamentous algæ furnish practically all of the food.

As is known, the Hydropsyche larvæ erect catching-nets of silk in front of the larval dwelling tube. The mouths of these nets face upstream, and the current flowing through, leaves entangled in the meshes, animals and plants too large to filter through them. The caddis worm uses its fore legs and mandibles for seizing its victim. Then, instead of chewing the prey, it proceeds to shove it into the mouth with its front legs until it entirely disappears.

The results of the action of the numerous teeth of the proventriculus during the contractions of the strong circular muscles are seen when a comparative study of the food-contents of the œsophageal region, proventriculus, and mid-intestine are made. The œsophagus often contains unmutilated Chironomid larvæ, and but slightly dismembered May-fly nymphs. In the lumen of the proventriculus, however, and in the grooves between the teeth are found separate mouth parts, tarsal claws, portions of caudal setæ, etc.

The hard parts of the food content are not held back by the proventriculus and vomited through the mouth as described by Ramme (1913) for Dytiscus circumcinctus, but pass through the whole alimentary tract, as has been observed in the Orthoptera. In Corydalis, also, a mandible of an insect has been found in the hind intestine. In examining the fine food broth of the mid-intestine many small pieces of chitin are found.

The interlocking of the numerous, forward-pointing bristles in the posterior region of the proventriculus makes an excellent strainer for holding back particles which have not been sufficiently ground. The two valves act as a stopper and by a regulation of the size of the lumen between them, which is brought about by the action of the circular muscles, a gradual passage of food into the mid-intestine is insured.

As far as I have been able to observe in Hydropsyche, I find no evidence to support the view that the proventriculus serves as an organ to facilitate the passage of the mid-intestinal secretion

into the crop. It seems in this larva to be an organ well adapted to performing two functions, the anterior part serving to triturate the food, while the posterior part acts as a strainer and also brings about a gradual passage of food into the mid-intestine.

## V. Summary

1. The proventriculus in the Order Trichoptera has been little studied and this organ in the larva of Hydropsyche shows it to be very well developed.

2. It is unique in the large number of well-developed teeth in the anterior part of the organ, and in the presence of two valves in the posterior region which are continuous with the œsophageal valve.

3. The œsophageal valve, instead of being a complete tube, is open along its whole extent on one side.

4. The arrangement of muscle layers in the fore-intestine is the reverse of that typically found in insects, and consists of an inner layer of circular muscles and an outer layer of longitudinal muscles.

5. The teeth are comparatively solid, lacking the lining of epithelial cells found in forms previously described.

6. The chitin of the teeth is formed in part by a secretion of epithelium and in part by a transformation of the cytoplasm of these cells.

7. The anterior part of the organ serves to triturate hard parts of the food, while the posterior part acts as a strainer and also permits a gradual passage of food into the mid-intestine.

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## EXPLANATION OF PLATE

Figure 1. Diagram of digestive tract showing position of the proventriculus (P); *Ms,* mesothorax; *Mt,* metathorax.

Figure 2. Portion of proventriculus opened to show the modifications of the chitinous lining. *Tl,* large tooth; *Ts,* small tooth; *Sp,* anteriorly-directed spines; *V,* valve; *Fd, 1,* primary fold; *Fd, 2,* secondary fold.

Figure 3. Drawing of some of the teeth as seen from the side, showing a group of five large teeth, separated by a small tooth.

Figure 4. Longitudinal section through the proventriculus (*P-P'*) and oesphageal valve (*Oe. v.*); *Oe,* oesphagus; *Lm,* longitudinal muscles; *Cm,* circular muscles; *Ep,* epithelium; *Ep. col.,* columnar epithelium; *Ch,* chitin.

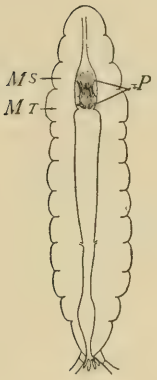
Figure 5. Cross section through a few teeth in formation showing the cytoplasm (*Cy*) of the epithelium extending to the apex of the tooth.

Figure 6. Fully formed tooth. Heavy stippling indicates cytoplasm that has been transformed into chitin.

Figure 7. Cross section through region of valves. *St,* stopper; *Lm, 1,* longitudinal muscle fibres; *Lm. 2,* longitudinal strands formed by the union of several *Lm. 1.*

Figure 8. Cross section through region of oesphageal valve. *O,* open side of tube.

Figure 9. Two valves and oesophageal valve dissected out to show that latter is not a closed tube. *F,* free edge of tube thickened, and bearing chitinous tooth-like projections; *CB,* dotted line indicates position of circular band of teeth. The folds normally come together, but have been separated in this drawing.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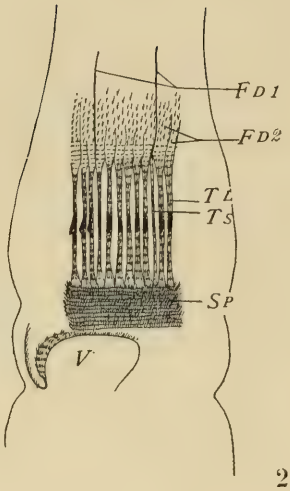
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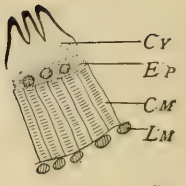
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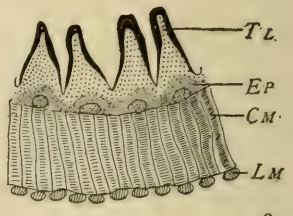
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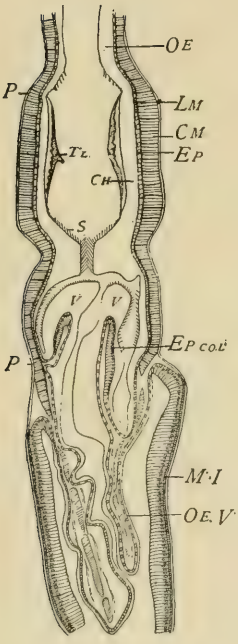
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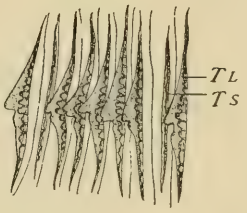
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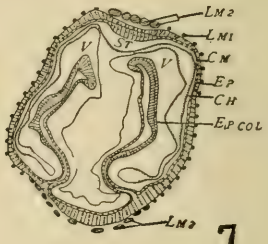
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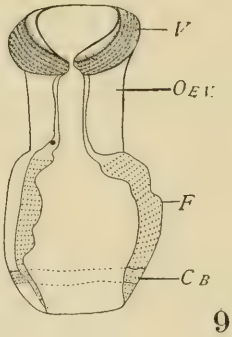
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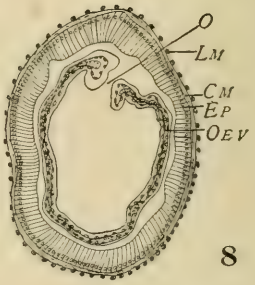
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# Notes on the Life History and Habits of the Rose Scale, *Aulacaspis rosæ* Bouche

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The present paper on the rose scale is based on observations made in the vicinity of Stanford University from December, 1912, to April, 1914. The paper was prepared in the Entomological Laboratory of Stanford University.

## LIFE HISTORY AND HABITS

The rose scale is a common insect pest of blackberries, raspberries and roses. It is widely distributed throughout the world. The most comprehensive paper dealing with the biology of this insect is found in Bulletin 159, 1902, of the New Jersey Experiment Station. In this bulletin, Dr. John B. Smith gives a detailed account of the life history and habits of this insect in New Jersey. Nothing has been published in regard to the biology of the rose scale on the Pacific Coast.

### A. DEVELOPMENT

#### 1. The Adult Female

The female scale is dirty white. Its shape is subcircular or widely ovate. The body is flat and elongated, orange yellow or golden yellow in color. As the eggs begin to develop, the body of the female turns orange color and the eggs are plainly visible through the body under a high magnification (Pl. I, Fig. 20). For a complete technical description of this insect, the readers should see Rep. U. S. Dept. Agric., 1880, p. 312, and Newstead's Mon. Brit. Coccidæ I, p. 168.

#### 2. The Egg and Its Oviposition

The minute and oval-shaped egg, not exceeding .11mm. in length, is orange yellow when first deposited (Pl. I, Fig. 2). It turns from pale to brownish yellow a few days later, and again changes to

brownish gray shortly before hatching. Most of the eggs are deposited early in the morning. The egg-laying period begins when the female is about five or six weeks old and lasts from two to four weeks, the eggs being laid a few at a time. The number of eggs deposited by seven females during their egg-laying periods was as follows: No. 1, 54; No. 2, 69; No. 3, 84; No. 4, 59; No. 5, 124; No. 6, 25; No. 7, 11; average, 61. As a rule, a single female deposits from forty to ninety eggs. It usually requires from two to ten minutes to deposit a single egg; in exceptional cases, about twenty-five minutes may be required.

### 3. The Method of Egg-hatching

The time required for the hatching of a single egg varies from twenty to thirty minutes. The following is an account of the hatching observed in the laboratory on January 25, 1913:

At 3:52 p.m.—the egg cracked anteriorly.
At 4:03 p.m.—the head and antennæ appeared.
At 4:18 p.m.—the front and middle legs appeared.
At 4:21 p.m.—the hind legs appeared.
At 4:23 p.m.—larva left the egg shell.

The writer has observed the egg-hatching more abundantly in the afternoon than in the morning. One observation was made to find out the number of eggs which hatched at the different periods of the day under the normal temperature and favorable condition in the laboratory, and the result was as follows:

| | Afternoon | Night | Forenoon |
|---|---|---|---|
| No. 1 (female)..... | 6 | 2 | 2 |
| No. 2 (female)..... | 4 | 3 | 1 |
| No. 3 (female)..... | 2 | 0 | 0 |
| No. 4 (female)..... | 8 | 1 | 3 |

### 4. First Larval Stage (active period)

The orange colored larva, when first hatched, is about the same size and shape as the egg. The five segmented antennæ (Pl. I, Fig. 7), three pairs of legs, and a pair of long hairs from the posterior margin of the body are plainly visible (Pl. I, Fig. 5). Most of the active larvæ crawl out from beneath the mother's scale within

two or three hours after hatching. The larvæ do not seem to migrate very far. They wander around five or six hours before they begin feeding. Plate I, Fig. 6 shows the wanderings of an active larva on a sheet of paper. The larvæ of the fourth generation are comparatively active and migrate quite a distance on the infested shoot, usually going toward the tip. The following table shows distances between the mother of this generation and the place where the young settled (used sixteen selected canes of raspberries and always took the highest measurement from each cane; allowed but one female on each shoot) :

| | | | |
|---|---|---|---|
| No. 1 | 20½ inches | No. 9 | 14¾ inches |
| No. 2 | 23½ " | No. 10 | 21 " |
| No. 3 | 12 " | No. 11 | 26 " |
| No. 4 | 16¾ " | No. 12 | 21¼ " |
| No. 5 | 9 " | No. 13 | 23¾ " |
| No. 6 | 19¼ " | No. 14 | 23 " |
| No. 7 | 13¼ " | No. 15 | 26¾ " |
| No. 8 | 18¾ " | No. 16 | 18¼ " |

The larva of the first, second and third generations usually settle toward the base of the canes. The active larva commences to take its first meal just as soon as it settles down, pushing the long needle-like mouth parts into the tissue of the plant. The antennæ and legs then rest perfectly flat on the bark. In several days, the body of the young gradually turns from pale orange to dark brown color. Now a soft cottony secretion can be seen from the posterior margin of the young. Just underneath it, a waxy substance is formed a few days later and it grows continuously until the size increases to two or three times the size of the body. The waxy substance finally becomes firm and scaly at this time. Scale of the female can be readily distinguished from that of the male about this time by its ovate shape (Pl. I, Fig. 15).

### 5. Second Stage of the Female Larva

After the first moult, the body grows rapidly and the pygidium takes the prominent shape with distinct groups of spinnerets and even the marked marginal plates. The insect in this stage is broad in the middle and more or less trapezoidal in front without

antennæ and legs (Pl. I, Fig. 16). The body segments are about three or four. The insect again secretes the waxy substance from almost all around the body which slowly takes a subcircular shape (Pl. I, Fig. 17). The female insect moults once more.

### 6. Third Stage of the Female Larva

After the second moult, the insect becomes almost like the adult, with widely rounded head and also with prominent plates and lobes of the pygidium (Pl. I, Fig. 18). The scale, which is flat at first, gradually becomes convex within about ten days after the second moult. The first exuvia turns to dark orange or brownish orange, and the second exuvia yellowish orange while the scale turns to dirty white. The larval or growing period usually requires from twenty-eight to thirty-seven days in the vicinity of Stanford University.

### 7. The Male Insect

Within about two weeks after the young are settled, the young male is recognizable by its arrow-head shaped scale (Pl. I, Fig. 10a). After the first moult, the head is distinguished from the rest of the body by a distinct segment, but the thorax is still fused with the abdomen (Pl. I, Fig. 10b). The scale of the young male is long and never becomes firm and scaly (Pl. I, Fig. 12). The growing period is as long as that of the female, but how long the pupal period lasts is not exactly known. In each generation, a large number of the young males are destroyed, as well as the female insects, by the "twice stabbed" lady-bird beetle (Pl. II, lower picture). The winged males issue about the time the female insects are full grown (Pl. I, Fig. 13). The newly-issued male usually walks about on the bark of the plant on which it issued, but it flies very little. It can not resist the wind and is easily blown down on the ground even by a slight breeze. It is often obliged to remain down for a while, and many die before being able to fly up again. The male requires about ten minutes for issuing after the head has appeared, and usually rests for a while before it commences to search for the female for mating. The life of the males is short, and most of them die within about twenty-five or forty-three hours after issuing.

## B. SEASONAL HISTORY

The year naturally divides itself into the season of rainfall corresponding to winter and the summer or dry season, as there is no marked seasonal change in this locality. The dry season in 1913 was extremely long and the wet season was short. Under such circumstances, the life history of the rose scale was worked out as follows:

### 1. The First Generation

The female insects which reached the adult stage late in December, 1912, began the egg-laying in the early and middle parts of January, 1913. The egg-hatching was first observed on January 13th, and was continued to the middle part of February. The larval period lasted for about a month. Some of the young females became full grown in March but most of them in the early part of April. The larval growth was long and irregular because the months of January, February and March in 1913 were cold and wet.

### 2. The Second Generation

The adult females were observed laying eggs through April. The egg-hatching was first noticed on April 27th in Palo Alto. Hatching was continued from then until the middle of May and became suddenly less toward the end of this month. The larval period lasted through June, but a few reached the adult stage as early as June 16th. A large number of young females became full grown between June 20th and July 10th. The winged males began issuing from the middle of June. Many young females of this generation were destroyed by a small hymenopterous parasite, which is a common enemy of the rose scale in this locality.

### 3. The Third Generation

The egg-laying was observed mostly in the middle and latter parts of July, and the egg-hatching was noticed abundantly toward the middle of August. The young females reached the adult stage toward the end of September, while the males had issued already in the early part of this month. The egg-laying was commenced in October and continued for about a month.

### 4. The Fourth Generation

The first egg-hatching of this generation was observed on October 24th. The egg-hatching was continued then to the latter part of November and became suddenly scarce in December. The larval growth was somewhat slow. The young females mostly reached the adult stage in the middle of December, but a few young were still found as late as December 22nd.

## NATURAL ENEMIES

Like other scale insects, the rose scale has serious natural enemies, such as the lady-bird beetles and some parasitic flies. The following enemies were particularly abundant in 1913:

### 1. *Chilocorus bivulnerus*

The well known "twice stabbed" lady-bird beetle preys on the rose scale and maintains a considerable control over the insect. This lady-bird feeds commonly on the rose scale throughout the year in this locality. The female beetle usually lays a single egg under the scale (Pl. I, Fig. 23). As the egg of the lady-bird hatches, the larva feeds first on the eggs or young. Both young and adults of *Chilocorus bivulnerus* feed on this scale insect, attacking mostly the young scales.

### 2. *Scymnus marginicollis* Mann

This is a tiny, blackish beetle without any spots on the elytra. I found the adult beetles mostly in Spring and Summer times feeding on the rose scale. I have not been able to find the eggs of this beetle.

### 3. *A hymenopterous parasite*

This is a small, black, four-winged parasite not exceeding 1.1 mm. in length (Pl. I, Fig. 22). The legs and antennæ are pale yellow. A large percentage of young females of the rose scale is destroyed by this parasite (Pl. I, Fig. 21). Out of 120 scale insects examined, 48 were killed by these flies. I have not been able to observe the egg-laying habits of this parasite. Its life circle, however, seems to be a short one. This parasite is now in the hands of Dr. L. O. Howard of Bureau of Entomology, U. S. Dept. of Agric., for determination.

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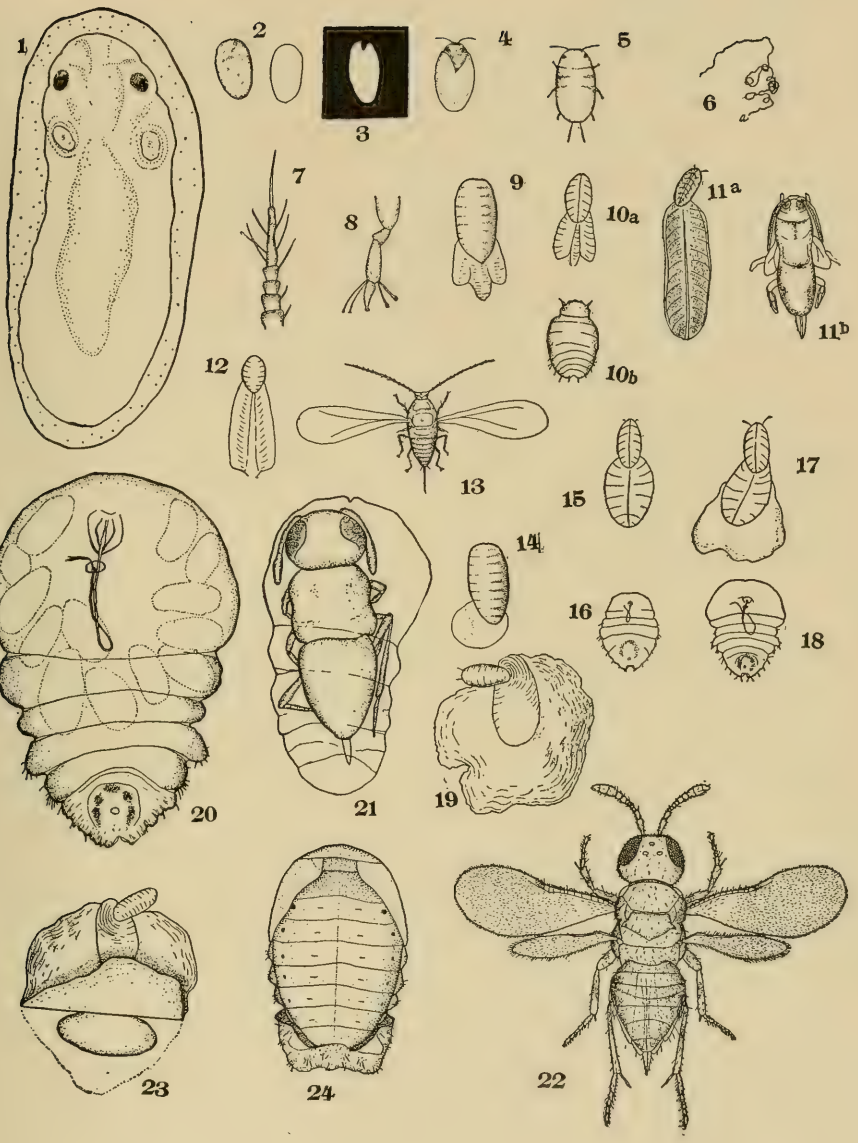
## EXPLANATION OF PLATE I

ROSE SCALE, AULACASPIS ROSÆ AND SOME OF ITS ENEMIES

Figure 1. Embryo of the rose scale.
Figure 2. Eggs of the scale insect.
Figure 3. The egg-shell.
Figure 4. A young of the rose scale just hatching.
Figure 5. An active larva.
Figure 6. Showing the wandering of active larva on a sheet of paper.
Figure 7. Antenna of the active larva.
Figure 8. A portion of the hind leg of the young.
Figure 9. Young male beginning the secretion of the scale.
Figure 10a. Scale of the young after the first moult.
Figure 10b. The young male after the first moult.
Figure 11a. The scale of male in the pupal stage.
Figure 11b. A pupa of the male.
Figure 12. Scale of the male adult.
Figure 13. The adult male of the rose scale.
Figure 14. Young female beginning the secretion of the scale.
Figure 15. Scale of the young female after the first moult.
Figure 16. The young female after the first moult.
Figure 17. Scale of the young female after the second moult.
Figure 18. The female after the second moult.
Figure 19. A full grown female scale.
Figure 20. A full grown female insect.
Figure 21. The pupa of a hymenopterous parasite inside of the scale insect.
Figure 22. The adult of the parasite.
Figure 23. Part of scale of female turned back to show the egg of *Chilocorus bivulnerus* lying under the scale.
Figure 24. The pupa of *Chilocorus bivulnerus*.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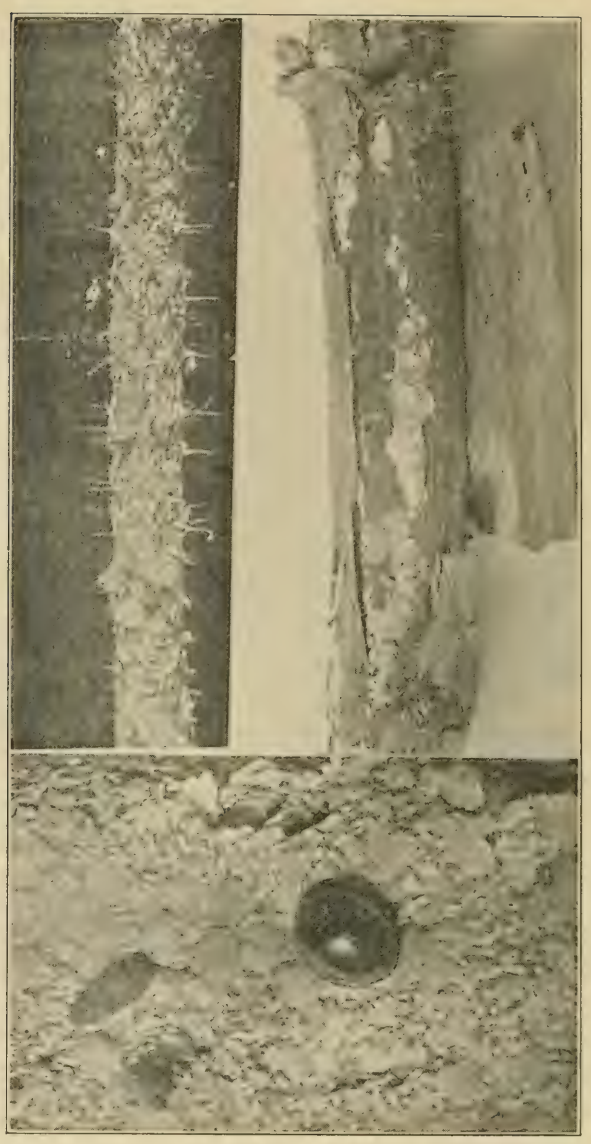


Plate II. Upper left-hand picture showing a blackberry cane infested by the rose scale, about natural size; upper right-hand picture showing habit of the rose scale wintering under the bark of raspberry cane (enlarged); the lower picture showing Chilocorus bivulnerus feeding on the rose scale (enlarged); original.

# Caprellidæ From Laguna Beach, II

R. LA FOLLETTE

Three genera are included, among them, two new species. Four species were considered in an earlier number of this publication, making a total of seven species of the family Caprellidæ from Laguna. Although the territory accessible at low tide was very thoroughly worked over, yet no doubt several more species could be secured in the deeper water off shore by dredging, and the list of forms is not yet complete.

*Caprella acutifrons* Latreille

Mayer in his description of the Caprellidæ of the Siboga Expedition, gives as many as ten varieties under the species name *acutifrons*. Among them the variety, *verrucosa,* which includes several specimens from California, is quite similar to my specimens here described, but I think it best to only use the species name *acutifrons* at present.

The peraeon of the male (Plate I, Fig. 1), is covered with several blunt prominences and many short blunt tubercles, the latter as in C. *geometrica.* Cephalon with a short horizontal spine; first segment of body a little shorter than the next three, which are of equal length; fifth about as long as the first; sixth and seventh shorter, respectively. The branchia are ovate, slightly longer than broad and moderate in size. Both pairs of antennæ missing in my specimen. Eyes small and round. First gnathopod small, about one-fourth as large as the second and attached far forward; palm broad, triangular shaped, tapering toward the finger with a few scattered hairs along the border and four tooth-like spines at the base; finger finely toothed along the inner margin. Second gnathopod (Fig. 2) attached about the middle of the second segment, basal joint short and thick, equal in length to the other joints combined; palm broad and toothed as in C. *geometrica;* inner margin slightly concave and armed with a few short hairs and a large prominent tooth at the base and a large flat tooth at the distal extremity; finger short and massive. Third, fourth and fifth peræpods (Fig. 1), similar in

shape and structure, being stout and covered with many short blunt tubercles and a few scattered hairs; palm narrow, concave and armed with two serrate teeth at the base; finger short and stout.

Length of specimen, 12 mm. Color a light brown to flesh color.

One male specimen collected from among the seaweed of the inner tide pools at Laguna Beach in July, 1914.

*Caprella uniforma* n. sp.

The peraeon of the female (Plate I, Fig. 3) is smooth; cephalon furnished with a slight prominence in front directed horizontally. First segment short, about half as long as the second, third, fourth and fifth, which are of nearly equal length; sixth and seventh much shorter, about a third as long as the fifth, the seventh being the shorter of the two. Superior antennæ about half as long as the first two body segments; first joint as long as cephalon and twice as broad as the second joint, which is nearly twice as long as the first; third joint not as thick as the second and one-third as long. Flagellum equal in length to the peduncle and composed of eleven segments. Inferior antennæ but slightly shorter than the superior, furnished with many plumose hairs. Eyes large and round. First gnathopod (Fig. 4) attached anterior to the base of the maxillipeds, large but slightly smaller than the second gnathopod; palm narrow, inner margin finely denticulate, armed with many scattered hairs and four blunt teeth at the base; claw broad and armed with many fine teeth along the inner margin. Second gnathopod (Fig. 5) but slightly larger than the first; basal joint long, longer than the palm; palm narrow, armed with a few hairs and two blunt teeth near the margin, the longer on the margin, and the shorter posterior to it; finger narrow and short. Branchia ovate. Third, fourth and fifth peraepods (Fig. 3), similar in structure and increasing in size respectively, the fifth being nearly a third longer than the third; hand narrow, armed with two serrate teeth at the base and a few hairs; claw short and sharp.

Length 14 mm.

Color, a light brownish green. The male specimens taken were quite similar to the female, including the shape of body segments and gnathopods.

Several specimens taken from a holdfast cast upon the beach at Laguna during July, 1914.

*Æginella hirsuta* n. sp.

In the adult male the peraeon (Plate II, Fig. 6) is smooth and devoid of a horizontal spine; first two segments short and of equal length although the second is the thicker; third and fourth equal in length and nearly twice as long as the second; fifth longer than the fourth but not as thick; sixth and seventh a fourth as long as the fifth, decreasing in size respectively. The superior antennæ are only half as long as the body; first joint a little longer than the cephalon; second joint longer than the first but not as thick; third joint only half as long as the second and half as thick; flagellum two-thirds as long as the peduncle and made of 16 segments. Inferior antennæ about as long as the peduncle of the superior and armed with many long hairs on the dorsal surface; flagellum two-jointed. Mandible (Fig. 10) made up of a strong cutting plate with five unequal teeth and a large rounded secondary plate with a few short prominences; several feathery hairs lie between the two plates and the mandible is supplied with a three-jointed palp. The first gnathopod (Fig. 12) is small and attached far forward; palm broad, nearly as wide at the base as the tip and armed with two spine-like teeth at the base and a few scattered hairs; edge finely toothed; claw medium and toothed with many small and a few regular teeth. Second gnathopod (Fig. 7) attached far forward on the second body segment; first joint longer than the others combined; palm long and narrow and armed with a small toothed lobe at the base and another larger tooth a little posterior; margin thickly covered with many long hairs; finger long, curved and also lined with many hairs along the inner margin. Fig. 8 shows the second gnathopod of a younger specimen, 10 mm. long; the palm is thicker, the inner margin not as regular in outline and armed with fewer hairs, while the finger is shorter than in the adult. Fig. 9 is the second gnathopod of a still younger specimen, 7 mm. long; the palm is much shorter and thicker and the inner margin lacks the second spine at the base and has a few blunt prominences at the posterior extremity and but few hairs; the finger is similar in shape to that of the adult. The third, fourth and fifth peraepods (Fig.

11), are similar in shape, being long and narrow; the third is somewhat shorter than the fourth and fifth; hand narrow and armed with a few hairs along each margin and two spine-like teeth at the base; finger long and sharp.

Length of adult male, 2 cm.

Color a light yellowish brown with a few brown spots.

Two adult specimens were taken at Laguna Beach in July, 1914, about a quarter mile off shore while dredging. Several specimens of the young, both male and female (Fig. 13), were collected from among the Rhodophyceæ in shallow pools at low tide. They were dark red in color like the seaweed and resemble the adults in every respect except those mentioned above and the antennæ, the superior pair being but slightly longer than the inferior; flagellum with but six to eight joints; inferior pair reaching to the last two joints of the flagellum of the superior.

*Paedaridium breve* n. sp.

Peraeon (Plate III, Fig. 14) comparatively smooth; cephalon devoid of a horizontally directed spine, and skull-shaped; neck very short; first three body segments of nearly equal length and rather stout; fourth segment about twice as long as the third and narrowing at the caudal end; fifth and sixth segments a little longer than the fourth and about half as broad; seventh about one-fourth as long as the sixth and narrow. Superior antennæ (Fig. 16), only slightly longer than the first body segment; first segment short and stout; second about twice as long and narrower; third shorter than the second; flagellum made up of two joints and armed with a few short hairs at the distal extremity. Inferior antennæ (Fig. 16) devoid of motor seta, nearly as long as the superior and fitted with a two-jointed flagellum. Mandible (Fig. 15) with a three-jointed palp armed with a few hairs; six irregular teeth on the mandible plate, three of which are large, the first being split into two divisions. Branchia on the third and fourth segments, ovate. Eyes small and round. First gnathopod (Fig. 17) attached far forward on the first segment; first joint long and narrow, longer than the palm; wrist broad; palm similar in shape to that of the second gnathopod and armed with two heavy spines at the base and numerous hairs

along the margin. Second gnathopod (Fig. 18) twice as large as the first and attached far forward on the second segment; first joint as long as the hand; palm broad and slightly convex on both margins, armed with three short, heavy spines on a slight prominence at the base and many hairs along the inner margin; finger reaching to the spiny prominence on the palm and uniform in outline. First peraepod attached at the base of the gill on the third body segment and made up of three small joints. Second peraepod attached at the base of the gill on the fourth segment and composed of but one short segment. Third peraepod (Fig. 14) attached just posterior of the center of the fifth body segment and composed of three segments; the first two of equal length, third very short; total length 1 mm. Fourth and fifth peraepods (Fig. 14) normal, having proper number of segments and of nearly equal length; palm and claw as long as the other segments of the peraepod combined; palm narrow, armed with a few regularly placed spines; finger but slightly curved.

Length 3 mm.

Color light pink to white.

Several specimens collected from the seaweeds at low tide, Laguna Beach, July, 1914.

*(Contribution from the Zoological Laboratory of Pomona College)*

## EXPLANATION OF PLATE I.

C. *acutifrons*

Figure 1. Body showing length of segments and fifth peraepod ×16⅔.
Figure 2. Second gnathopod ×50.

C. *uniforma*

Figure 3. Body of female showing branchia and peraepods ×16⅔.
Figure 4. First gnathopod ×50.
Figure 5. Second gnathopod ×50.

## EXPLANATION OF PLATE II.

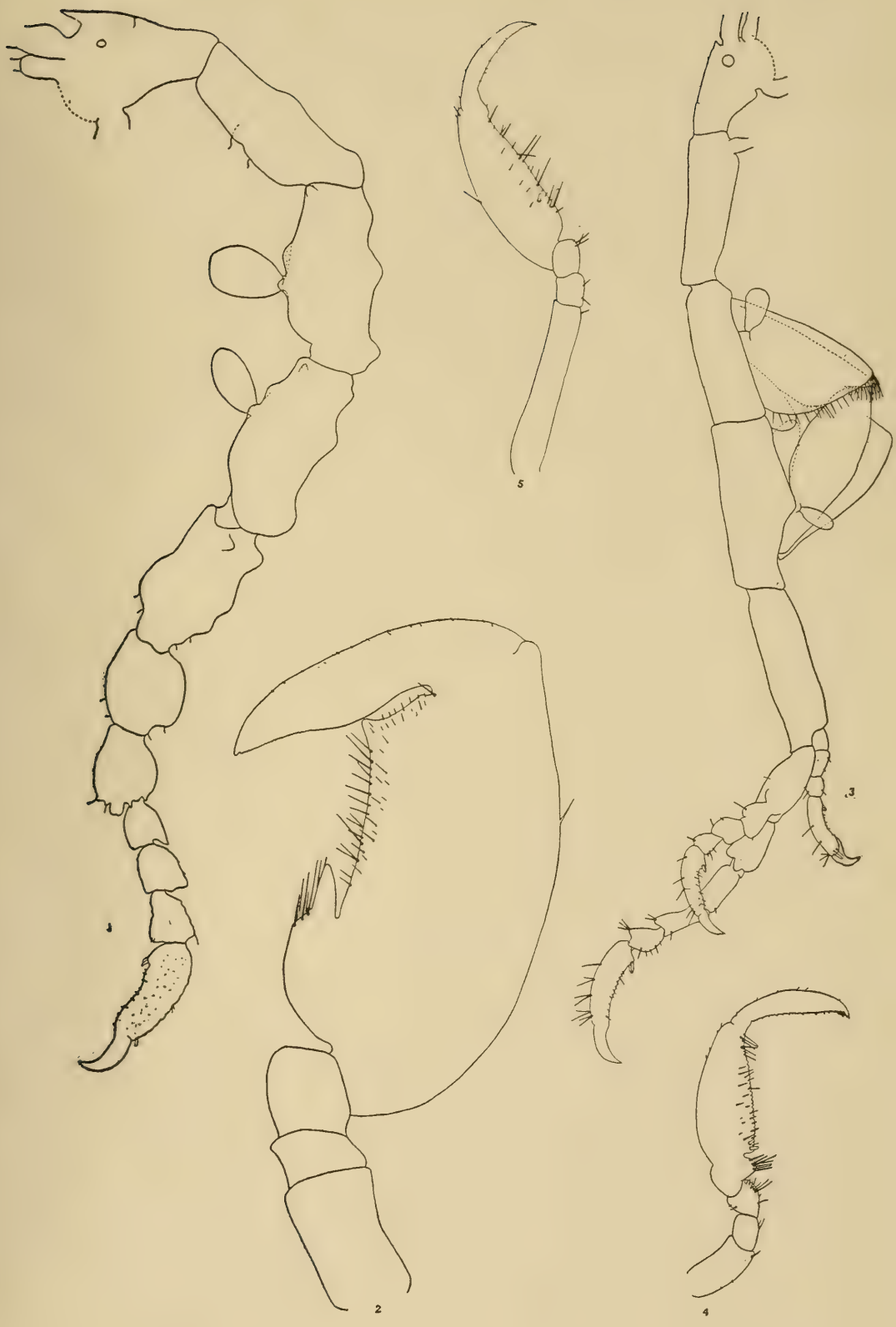
A. *hirsuta*

Figure 6. Body of male ×25.
Figure 7. Second gnathopod of adult male ×25.
Figure 8. Second gnathopod of younger form ×25.
Figure 9. Second gnathopod of still younger form ×75.
Figure 10. Mandible and palp ×300.
Figure 11. Fifth peraepod ×25.
Figure 12. First gnathopod adult ×25.
Figure 13. Body of young female ×75.

## EXPLANATION OF PLATE III.

*Paedaridium breve* n. sp.

Figure 14. Body showing length of segment and peraepods ×25.
Figure 15. Mandible ×300.
Figure 16. Antennæ ×25.
Figure 17. First gnathopod ×75.
Figure 18. Second gnathopod ×75.
Figure 19. Fifth peraepod ×75.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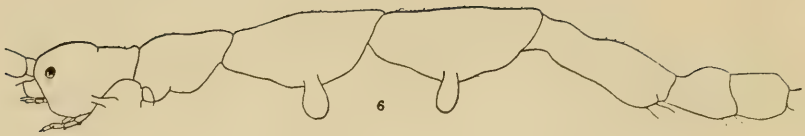
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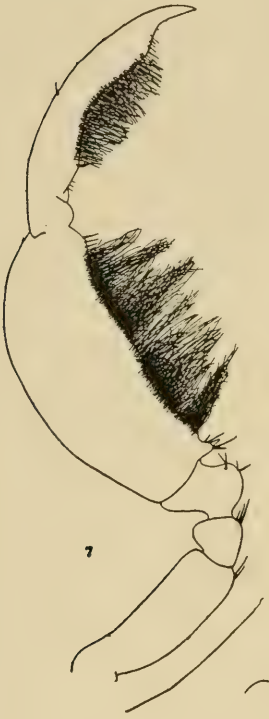
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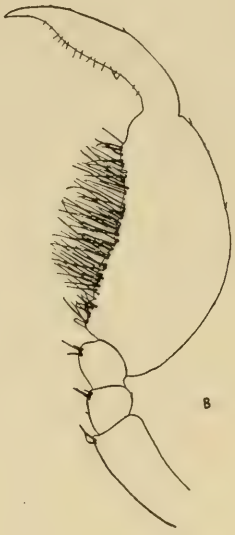
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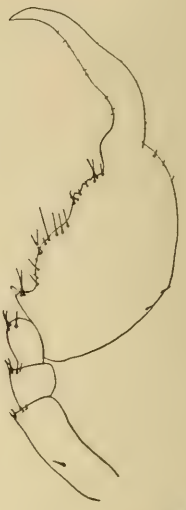

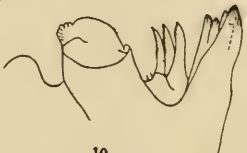
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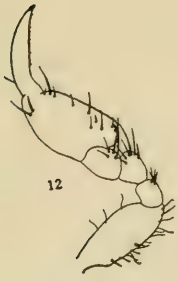
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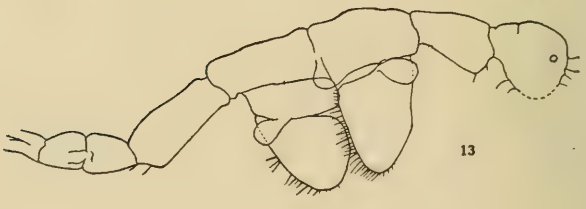
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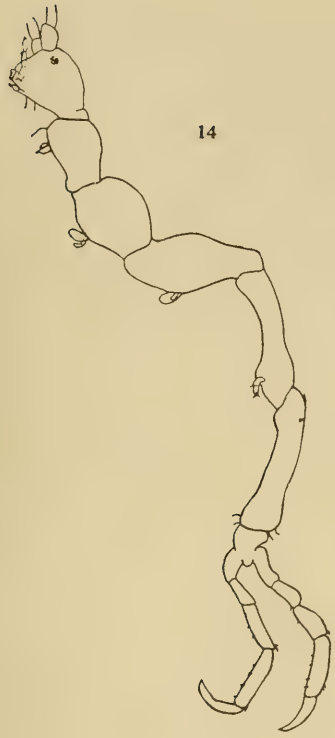

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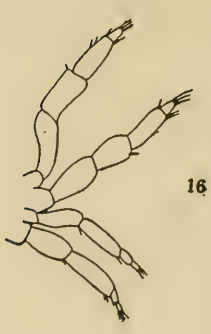

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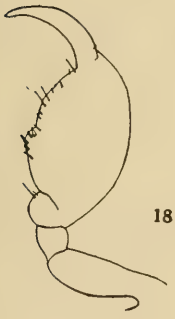

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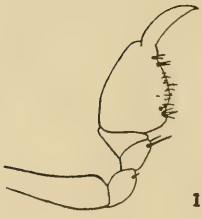

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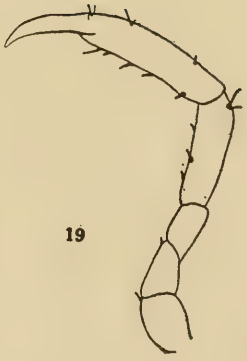

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# A Remarkable New Brittle Star

HUBERT LYMAN CLARK

OPHIOCRYPTUS gen. nov.

ὄφις=*snake* (a very common prefix for genera of brittle stars)
κρυπτός=*concealed;* in reference to the concealment of the disk scales and arm plates by granules.)

Disk covered with rather swollen plates, which are either completely concealed by coarse granules or are bare at the middle only. Upper surface of arm more or less covered, with a coat of granules. Oral shields (except madreporite), adoral plates and oral plates, completely concealed by a coat of granules continuous with that which covers the interbrachial areas. Arm spines short and thick. Genital slits, four in each interbrachial area. Tentacle scales 2, well developed.

Type-species: *Ophiocryptus maculosus* sp. nov. (see below).

This genus is nearly related to Ophioncus, described by Ives (1889) from the "West Coast of North America." The complete concealment of the mouth plates by granules and the large amount of granulation on the arms are important differences, however, and prevent assigning the present species to Ives' genus. Moreover the bareness of certain disk-plates at their center while the radial shields are entirely concealed is an odd feature. Koehler has recently described and figured (1914, Bulletin 84, U. S. Nat. Mus., p. 8; pl. 2, figs. 1,2) an interesting little ophiodermatid from the Bahamas, which he considers a young Ophioderma. His admirable photographs show however that it is very close to the species I am here describing, but differs in having longer arms and bare radial shields. In the last particular and in the uniform granulation of the disk, it resembles Ophioncus. As it has six arm spines I suggest that it may well be called *Ophiocryptus hexacanthus.* The type is U. S. Nat. Mus. Ac. No. 41471, and is from Green Cay, Bahamas.

OPHIOCRYPTUS MACULOSUS sp. nov. (*maculosus* = spotted)

Disk 6 mm. in diameter; arms 9 mm. long, flattened, especially near tip, of 17 visible joints. Disk evidently covered by rather

large, somewhat swollen plates, 80 to 100 in number, counting the small ones, but excepting the central portion of 12-15 of the largest, these are all concealed by a fairly uniform coat of granules, about 50-75 per sq. mm. No radial shields can be distinguished. The coat of granules extends along the upper surface of the arm to the very tip and covers also most of the surface of the basal side arm plates; many of the upper arm plates are bare at the center, but others are completely hidden. Interbrachial areas below covered by a uniform coat of granules which extends clear to the very jaw tips, completely concealing the oral shields (except the madreporite, which is largely bare), the adoral and the oral plates. Oral papillæ, 10-12 on each side, large and thick, not at all, except the distalmost, squamiform. Those near the tip of the jaw and the penultimate are the largest, while the middle ones are somewhat smaller; they are roundish and blunt, twice as long as thick. First under arm plate small, triangular; succeeding plates longer than wide, basal ones in contact, much wider distally than proximally and with distal margin strongly convex and a little swollen; they are somewhat hexagonal, but the three proximal sides are very short, while the distal lateral sides are long and concave. Side arm plates moderately large and projecting; each carries a series of five short, thick, almost conical, subequal spines, scarcely half as long as a joint; the spine-ridge is near the middle of the plate and the spines stand more or less straight out from it. Tentacle scales two, very large and scale-like; on the terminal joints there is only a single scale. Color (dried) dirty whitish, brightest orally; disk spotted with minute brownish-red spots, widely and irregularly spaced. A smaller specimen, preserved in formalin, has the upper surface of the arms quite pink or rose-colored and the spots on the disk are distinctly red.

This very remarkable brittle star was sent to me by Professor W. A. Hilton, who discovered it among kelp "holdfasts" at Laguna Beach, California, July 24, 1914. The holotype is in the collection of the Museum of Comparative Zoölogy, Cambridge, Mass. (Cat. No. 3914), while a paratype remains with Professor Hilton. The resemblance to the Bahamas species, referred to above, is particularly marked in the oral view but in *maculosus* the madreporite is

notably bare, while in *hexacanthus* it is indistinguishable. Seen from above, the smooth, nearly pentagonal disk of *hexacanthus* with bare radial shields, is markedly different from the somewhat swollen disk of *maculosus,* bulging a little in each interradius, covered with more or less lumpy plates and with concealed radial shields. In *hexacanthus* the arms are more than twice the diameter of the disk, while in *maculosus* they are only once and a half the disk diameter. It is to be hoped that further material of both species will soon be secured to throw light on the habits as well as on the morphology. It is particularly important to learn to what extent the granulation of disk and arms is variable. If individual diversity in this feature is very great, a good series of specimens may demonstrate that Ophioncus and Ophiocryptus are identical.

# Pycnogonids Collected During the Summer of 1914, at Laguna Beach

WILLIAM A. HILTON

The collection began on July 9 and a few specimens were obtained as late as November 15. As there are a number of new records as well as some new points in connection with distribution it seemed best to publish this list for the aid of future workers.

At Laguna there are three well defined litoral regions where pycnogonids are found and in some of these they are very abundant. To a large degree several species are distributed in these regions in such a way as to escape casual observation. Although it is convenient to recognize these three localities, yet it must be admitted that there is some degree of overlapping. The regions are as follows: 1st, under stones at moderately low tides not necessarily far out; 2nd, among coarse polyzoan colonies which are found attached to rock ledges or on the margins of large stones; 3rd, the red sea weed locality, especially among those growing on mussels well out on rocky points.

The specimens were determined by the papers of Cole, Hall and a number of others. As there is some variation in the cephalic appendages and as these are much used in determination, their general character and number of joints are given under the name of each species. Numbers: I for chelifori, II for palpi, III for ovigers.

## Family PALLENIDÆ

### *Pallene californiensis* Hall

I 2 j. chelate, II lacking, III 10 j. Slender body. Twenty-five specimens of these were collected, some young and very small and delicate. The strong jaws of the first appendage are especially noticeable. The body and legs are very light colored. A number of males were obtained carrying the large eggs which are marked in this genus. Almost all of these were found among the white tangled stems and zooids of polyzoans which they closely resembled.

## Family AMMOTHEIDÆ

*Lecythorhynchus marginatus* Cole

I 1, II 9, III 10. In a few cases I seemed to be two-jointed, but this was due to internal structures and not a true joint. III in a number of cases had fewer joints than 10; it is possible that these were young or the results of mutilations. This is one of the larger species. The body and legs are of a reddish brown color. Sixty-five specimens were obtained; many of the males bore eggs. They were found among the red seaweeds, especially among mussels well out on the points. Their colors matched those of the red seaweeds with which they were associated; they were seldom found where Caprellidæ were abundant.

*Ammothella tuberculata* Cole

I 3, II 9, III 10 joints. Tubercles on the dorsum, light brown in color. Thirteen specimens were obtained, found usually among the older strongly chitinized polyzoan branches; also found occasionally among similar growths on mussels.

*Ammothella bi-unguiculata* var. *californica* Hall

I 3 j. chelate, II 9, III 10. Straw colored; found among mussels. Two specimens found, neither with eggs.

*Ammothella spinosissima* Hall

I 3, II 9, III 10. Three large branched spines on the back. Branched spines on the legs. This very interesting pycnogonid was found under stones. Four specimens were obtained; two of these bore eggs. The long spines and hairs catch sand grains and may make the individuals look like little heaps of sand. All were found under stones.

*Tanystylum intermedium* Cole

I 2, II 6-7, III 10. These small white pycnogonids were very abundant among Polyzoa. A few were found wandering from this locality. Sixty-five specimens were collected, many with eggs.

*Tanystylum orbiculare* Wilson

I 1, II 6, III 10. I have some doubt as to this determination. This may be a new species, but it is similar to the eastern form.

Strongly chitinized with ridges of yellowish cuticle between the legs. These were found among the coarser polyzoan stems which they much resembled in shade and form. They were also found among mussels in similar situations. Forty-four specimens were found, a number of the males had eggs.

*Clotenia occidentalis* Cole

I 1, II 4, III 10. Rather strongly chitinized, found among old polyzoan stalks and among mussels. Two specimens.

## Family PHOXICHILIDIIDÆ

*Phoxichilidium femoratum* Cole

I 2 chelate, II absent, III 5. Light brown, among mussels. Two specimens.

*Halosoma viridintestinalis* Cole

I 2 chelate, II absent, III 6. Elongate body, light brown. Three ward. Disc shaped body. This is the smallest pycnogonid at Laguna. Found among the zooids of polyzoan colonies. Twenty specimens, a number with eggs.

*Anoplodactylus californicus* Hall

I 2 chelate, II absent, III 5. First trunk segment projects for-specimens found among mussels.

## Family PYCNOGONIDÆ

*Pycnogonium stearnsi* Ives

I no joints, II none, III 10 joints in male, none in female. Broad thick legs, light brown body. Two found among mussels July 9. One of these was a male with eggs, one a female.

## Family NYMPHONIDÆ

*Nymphon* sp.

I 3 chelate, II 6, III 8—three like this; one as follows: I 2-3, II 4-5, III 5-6. One or both of these may be new species. They were light brown in color and found among the darker stems of polyzoans; one or two among mussels.

In addition to these there were ten or more specimens collected that were not determined, some were immature, others were injured. In all about 250 specimens were collected.

The largest number were of three or four kinds. In spite of some wandering the pycnogonids seemed to resemble their surroundings to a remarkable degree, either in color or lack of color in the body and in the form and shape of the body and legs.

*(Contribution from the Zoological Laboratory of Pomona College)*

# The Central Nervous System of Nebalia

WILLIAM A. HILTON

A number of specimens of *Nebalia bipes* Fab. were fixed in various ways, serial sections were made and stained in Delafield's hematoxylin, carmine and iron hematoxylin. The last stain gave the best results.

The brain is composed of three parts of unequal size. The optic lobes connected with the stalked compound eyes are the largest of the three divisions. Due to the compound eyes this part of the brain is complex. A median longitudinal section through an optic lobe shows an arrangement of cells and fibers as follows: Next the eyes there is a rather thick, dense layer of cells chiefly noticeable because of their nuclei; back from this a smaller crescent-shaped mass of fibers is evident, followed by a zone of crossed fibers and scattered cells. The cross fibers are connected with a central rounded core of fibers which is separated slightly from two other masses. All are largely surrounded by cells.

Cross sections of the optic stalk or lobe give little indication of the several divisions of cells and fibers, the general appearance for most of the distance being of a central core of fibers surrounded by densely packed cells. Towards the junction of the lobes with the brain the cells less uniformly cover the central fibers. After the two lobes approach each other, the masses of cells on either side are massed together but not fused or united across the middle line, although the two lateral parts are closely applied to each other. Dorsally for a short distance, a thin band of cells which may not be functional nerve cells arch over and connect the two lateral halves of the brain, leaving a small cavity just below, which

is continuous with the line of separation between the two sides. Quite a little farther down, the central fibers which are continuous from the optic lobes meet with more ventral fibers which have gradually been making themselves evident, and it is possible to determine two additional masses of nerve fibers. It is at about this level or a little before that the two sides of the brain are fused for a short distance. The more dorsal mass of fibers represents those followed from the optic lobes, the middle fibrous mass is the core of the antennular portions of the brain, the ventral masses represent the centers of the antennal lobes. These masses are connected to the lobe or lobes near them. The middle fibrous portion does not remain distinct for long. Farther down there is but one central fibrous portion which may be called the antennal center. The connectives with the ventral chain of ganglia are without accompanying cells for only a short distance.

The ventral ganglia were found to be in about the same positions as earlier authors have described. There are eleven centers for the thoracic region and six for the abdominal. These thoracic centers are in a sense ganglia very closely connected. There are few indications of distinct right and left halves. The nerve cells in a way correspond to the position of appendages which are attached to this region of the body, but the dorsal and ventral masses of cells are not exactly over each other. The dorsal cell groups are especially interesting. They are found in great masses which overhang in two directions, toward the caudal end and towards the middle line, forming "neural crest" cells which may project so far from the general mass of the nervous system as to be shown as separate clumps of cells in cross sections.

The six abdominal ganglia are well separated from each other and at places show something of a paired nature. The nerve cells are not so numerous and do not project from the general surface. The last ganglion has but a few cells, mostly ventral ones. I agree with Packard, who says that the nervous system is not very complex, although one could learn very little from the figures which he shows to support this conclusion. Of course, there are the rather complex optic lobes connected with the stalked eyes, but these and other parts of the brain are not complicated by the deep

staining masses so characteristic of many arthropods. In no place is the fibrous mass of the brain or ganglia of great complexity. Fibers for the most part run in straight pathways, many connect the brain with lower levels, but possibly less than are usually found because the connectives with the brain are rather narrow. More or less continuous cell masses inclose the brain and upper ganglia. These cells are massed, there are several sizes and the staining reactions differ. In places some cells take a much deeper color.

There are not many indications of cross connections between right and left halves in the lower portion of the nervous system.

One of the most remarkable features of the brain is the failure of the more forward lateral portions to unite across the middle line. Back from the center fusion takes place above, but not at the dorsal surface. For a short distance three parts of the brain may be distinguished although they are largely fused with each other. Back of this the antennal lobes become distinctly separate, and at last end in the narrow connectives which run to the ventral ganglia.

The eleven thoracic ganglia may be determined by the position of the appendages of this region and to some degree also by the location of the nerve cell groups. The six abdominal ganglia are well marked from each other and towards the last the right and left connectives may be determined for the first time in the ventral chain.

Another interesting condition of the nervous system is found in the brain. A slight cavity remains for a time between the two lateral halves of the upper part of the brain in a dorsal position. This space is shut in above by a small mass or line of cells which may not be nerve cells, although they are joined with the brain. It seems as though the two lateral halves of the brain came together leaving a cavity between which they at last bridged over dorsally by the growth of adjacent parts. This suggests a similar formation of a cavity in the central nervous system of vertebrates at an early time.

## SUMMARY

1. The central nervous system consists of the brain of three fused ganglia, the ventral chain of about eleven centers and the six abdominal ganglia.

2. The brain is chiefly made up of the optic and antennal lobes; these are fused at the central portion of the brain with the lobes of the antennules. There is but a short portion of the brain fused from side to side.

3. Although there are connections from the brain to the lower levels these are not great because the connectives are narrow.

4. With the exception of the rather complex optic lobes the nervous system is of simple structure. There are no complex masses of tangled fibers and fibrils.

5. Cells sheath or accompany almost all parts of the central nervous system. They are also massed in projecting lobes or "neural crests" in the thoracic region, where they project caudally and towards the middle line.

6. A central cavity is formed in the central region of the brain where the two lateral halves are united only by a line of cells on the dorsal surface.

7. In spite of the fact that the animals are mature as determined by the germ cells, the nerve cells and nervous system seemed almost embryonic. The masses of cells in places seemed only slightly different from the body cells.

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*(Contribution from the Zoological Laboratory of Pomona College)*

## EXPLANATION OF FIGURES

Figure 1. *Nebalia* from the side. The position of the ganglia is indicated in the drawing. ×12½.

Figure 2. Longitudinal section of the central nervous system compiled from two adjoining sections. Elements of all the centers are shown. The brain is at the upper end.

Figure 3. Longitudinal section through an optic lobe. ×215.

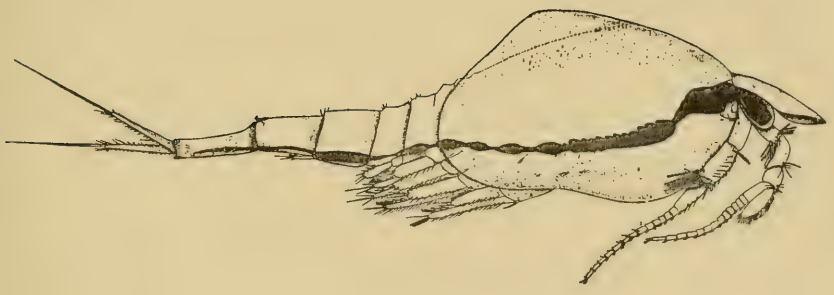
Figure 4. Cross section of an optic lobe. ×215.

Figure 5. Cross section of the upper portion of the brain. ×215.

Figure 6. Cross section of the central portion of the brain showing centers of fibres. ×215.

Figures 7 and 8. Lower sections through the brain. ×215.

Figures 9-12. Cross sections through ventral regions of the nervous system. ×215.

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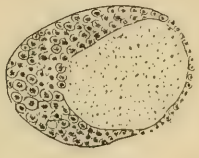
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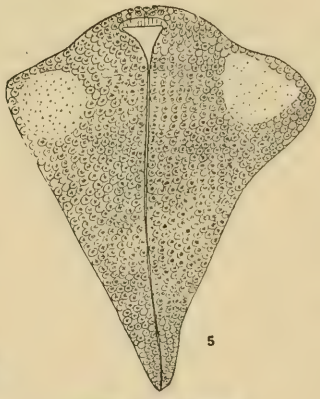
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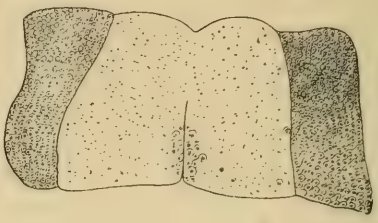
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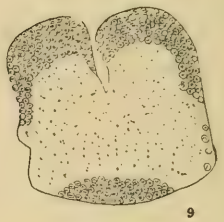
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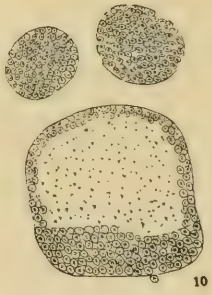
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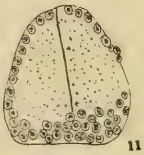
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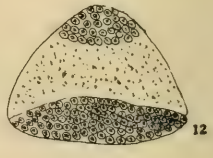
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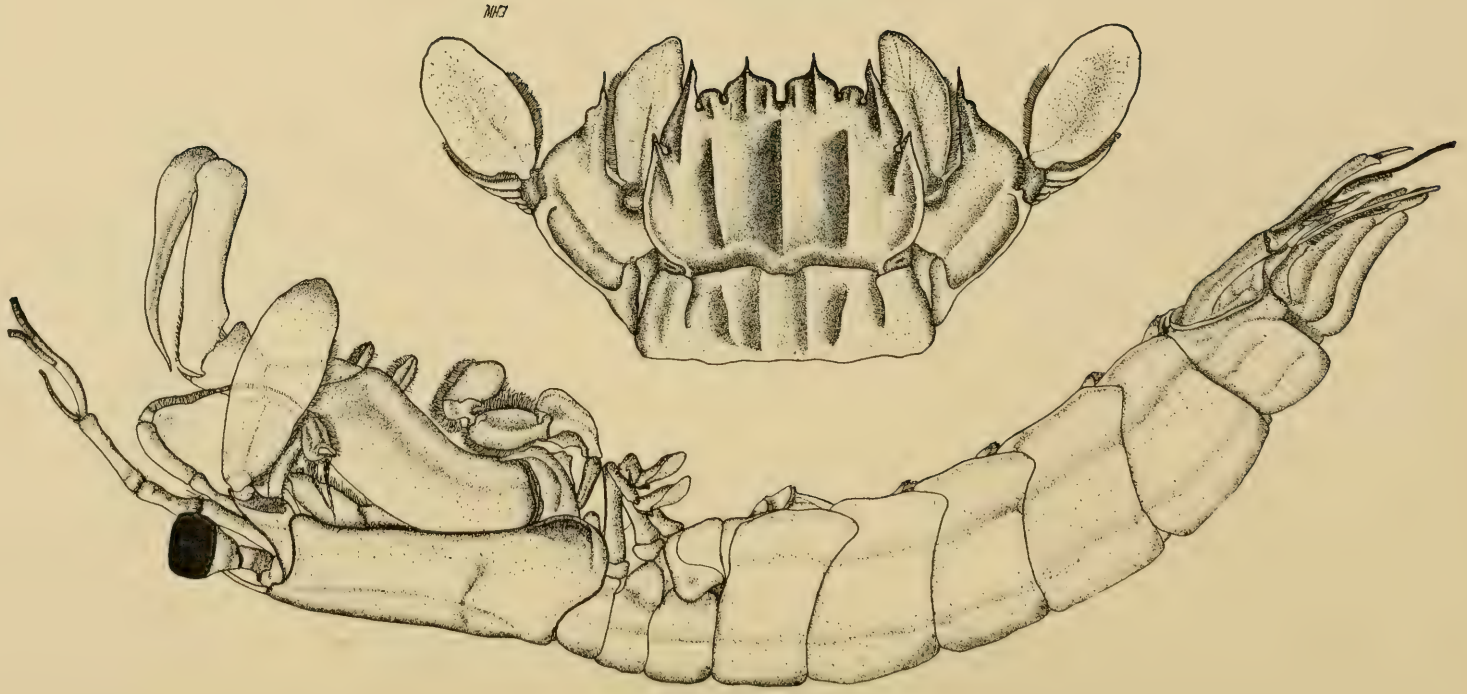
# Pseudosquilla From Laguna

Due to the kindness of the United States National Museum, the squilla-like crustacean obtained off shore from Laguna Beach during the summer of 1914 has been determined to be *Pseudosquilla bigelowi* Rathbun. The drawing of the animal and the drawing of the dorsal view of the caudal end were made by Mr. E. H. Welch, a student in Pomona College.—W. A. H.



# Wants and Exchanges

Subscribers and others are urged to use these columns to make their wants known. As the Journal goes to all parts of the world we hope to make this a very useful feature of the publication. Exchange notes are free to subscribers.

WANTED—Myriopods from all parts of the world. Will name, exchange or purchase. R. V. Chamberlin, Mu. Comp. Zoology, Harvard Univ., Cambridge, Mass.

Will exchange insects of any order from Southern California, for Microlepidoptera from any part of North America, preferably pinned, with complete data concerning capture. Fordyce Grinnell, Jr., Pasadena, Cal.

COCCIDÆ—California Coccidæ exchanged for specimens from all parts of the world. E. O. Essig, Dept. Entomology, University of California, Berkeley.

WANTED—Cephalopods (in alcohol); Chitons (in alcohol or dry); shells of West American Mollusca; zoological literature. Offered: West American and other molluscan shells; zoological pamphlets, mainly on the Mollusca. S. S. Berry, 502 Cajon St., Redlands, California.

California Syrphidæ, Aphididæ to exchange for non-California Syrphidæ. W. M. Davidson, Walnut Creek, Cal.

WANTED—For exchange, papers on marine and fresh-water Protozoa. Albert L. Barrows, Department of Zoology, University of California, Berkeley, Cal.

WANTED—Information on any mite-papers for sale or exchange that have an economic bearing. H. V. M. Hall, Room 8, Court House, San Diego, Cal.

WANTED—Specimens and separates relating to the pseudoscorpions, in exchange for local species. M. Moles, Claremont, Cal.

WANTED—Separates relating to the nervous system and sense organs of the invertebrates in exchange for reprints by a number of authors on this and other topics relating to the anatomy of invertebrate animals. W. A. Hilton, Claremont, Cal.

Tabanidæ from all parts of North America to exchange for Tabanidæ from the Western United States and Mexico and Central America. Jas. G. Hine, Ohio State University, Columbus, Ohio.

Sarcophagidæ from all parts of the world bought or exchanged, according to arrangement. North American material determined. R. R. Parker, Ent. Lab., Mass. Agri. College, Amherst, Mass.

# Notes on Brachycentrus Nigrisoma Banks*

J. T. LLOYD,
ITHACA, N. Y.

The larvæ of *Brachycentrus nigrisoma* Banks, *Trichoptera* of the family *Sericostomatidæ,* are dwellers in limited areas of the large spring-fed brooks in the McLean Bogs, near Ithaca, N. Y. Here, with their symmetrical cases firmly cemented to some solid support and opening against the swift current, the larvæ wait for some fragment of food to float within their powerful grasp.

Habitat: The larvæ are locally distributed in limited areas of Bear Creek, McLean, but are very abundant in the areas which they inhabit.

Larval Habits: The larvæ live sedentary lives with one edge of the large end of their cases firmly cemented to submerged rocks or sticks. Always they inhabit positions on the exposed surface of their support and always they face the unbroken current. While waiting for prey they assume the position shown in Figs. 6 and 8, protruding their heads slightly and extending their prothoracic legs straight forward. The mesothoracic legs are held upward while the metathoracic legs are extended to the sides. From this position they eagerly seize and quickly devour small larvæ or bits of vegetation that float within their grasp.

In the unnatural conditions of still-water aquaria in the laboratory they attach their cases and assume their characteristic attitude of outstretched arms. If a particle of food material be moved within their grasp it is eagerly seized and devoured, but if, however, the food be placed in front of the larva, even in contact with its limbs or jaws, it is ignored or pushed aside. Apparently the larva does not recognize food that is not moved into its grasp. From time to time larvæ confined in aquaria detached their cases and moved from place to place. It seems probable that the larvæ in the streams,

*Contribution from the Limnological Laboratory of the Department of Entomology in Cornell University.

also, at times move about in search of building material, for it is unlikely that chance would place enough suitable case-building material within their reach.

Larvæ which were put in the water after they had been exposed to the air until the moisture had dried from their cases, which accordingly floated, swam with their legs motionless and in the attitude assumed while waiting for prey. Their motion through the water was caused by the respiratory current being forced through the small openings at the caudal ends of their cases, after the manner of locomotion of certain dragonfly nymphs. This was probably an unnatural mode of locomotion, never practiced in nature, at least not by this species.

Food of the Larvæ: The contents of stomachs examined consisted of fragments of insects and small crustacea and two *Hydrachnids,* as well as small bits of the tissue of higher plants, some fragments of *Chlorophyceæ* and quantities of diatoms of several genera. This miscellaneous assortment of animal and vegetable foods from the stomach, as well as observations on the habits of the larvæ, leads us to believe that they will eat any organic matter that floats within their grasp. The combs of fine spines on the legs (Figs. 7, 14 and 3), probably serve as plankton sieves, and the long hooked armature of the tarsi (Figs. 7 and 14) certainly suggests carnivorous habits.

Pupal Habits: In preparation for pupation the larva spins a silken sheet (Fig. 16, C) across the front of the case. This sheet is perforated in the center by a number of small holes arranged in a circle. Surrounding the perforations there is an area which is free from perforations. At the caudal end of the pupa (about two-thirds the length of the case from its cephalic end) a second sheet of silk (Fig. 16, B), is spun across the case. This second sheet resembles the first, except that the circular area of perforations is larger. Pupation takes place on the exposed areas on sticks or stones where the larval life was spent.

Period of Emergence: Specimens confined in cages in their natural habitat emerged during the latter part of May and first part of June. No specimens were seen on the wing.

## DESCRIPTION OF LARVA, PUPA AND CASE

### Larva

The length of the mature larva (Fig. 7) is about 12 mm., its breadth is about 2.5 mm. In life the soft parts are green; the heavily chitinized parts are dark brown, appearing black when viewed in reflected light. The abdomen tapers gradually from the first to the last segment.

The head is black, marked with brown on the dorsum (Fig. 7); the sides are black with a brown mark extending back from the caudal margin of the eye to the caudal margin of the head as shown in the side of the figure; the venter is black, except the ventral mouth-parts which are brown; the labrum is black with setæ arranged (Fig. 2); its cephalic pair of setæ are saber-like and are directed toward the median line, their tips almost meeting, the other setæ are normal, the front margin is clothed with a dense fringe of hairs; the frons has the markings and distribution of setæ shown (Fig. 13); other mouth-parts are shown (Figs. 4 and 5).

The thorax is marked on the dorsum (Fig. 7); the prothorax has a depressed crescentic mark of brown across the dorsum and extending down the sides; the mesothorax is armed dorsally with four narrowly separated chitinous plates which are without markings, but are armed with long setæ (Fig. 7); on each side of the body there is a somewhat triangular plate; the metathorax is armed above with four smaller dorsal plates and a single plate on each side of the body (Fig. 7); on the sides the chitin of the dorsum of the prothorax extends to the base of the front legs; on the outside of each mesothoracic coxa there is a triangular piece of heavy chitin which bears a tuft of long black setæ on its front and on its ventral corners; the metathorax bears similar chitinous pieces, each of which has a single line of long black setæ around its cephalic corner and a line of similar setæ extending from a point on its cephalic margin well above its ventral corner to a point on its venter considerably below the limits of the chitinous triangle; the venter of the thoracic segments is without heavy chitin. The legs (Figs. 7 and 14) are all armed with powerful curved claws, the form and distribution of setæ is shown in the accompanying figures, the apical membranous

part of the front femur adjoining the tibia is somewhat membranous and is overspread with minute conic teeth; the inner edge of the trochanter and femur of the front leg is armed with a single row of long straw-colored hairs, and the femur is armed also with a row of short spines on its inner edge; the second and third pairs of legs are much alike; the inner edge of the femur is armed with a line of sharply pointed spines of two kinds, one kind, apparently very rigid, is dark in color and arises from well-defined sockets; these spines are separated by one, two or three spines of lighter color and apparently less rigidity, which do not arise from sockets; the spines in detail are shown (Fig. 3).

Figure 15 illustrates diagrammatically the arrangement of gills on the left side of the abdomen.

## Pupa

Length: 10-13 mm.
Breadth: 3-3.5 mm.

The mandibles are strongly chitinized. The antennæ reach to the tip of the abdomen. The dorsal plates of the abdomen and armature of the dorsal surface of the 1st segment are shown (Fig. 9); the hooks of the second series on the 5th segment are not borne on a single plate, but occur as independent chitinous pieces forming a line across the dorsum of the segment. Figure 10 shows the hooks in detail. A few minute setæ occur on each segment, these are slightly longer and more numerous on the last segment; the lower sides of segments 1-7 bear narrow obliquely downward-pointing lines of dark color; the last segment is shaped like an obtuse arrow head. When viewed from above it bears two curved processes which are equal to a little more than half its length. The lateral fringe is better developed than that of the larva; it begins behind the middle of the 5th segment and ends on the ventral side of segment eight.

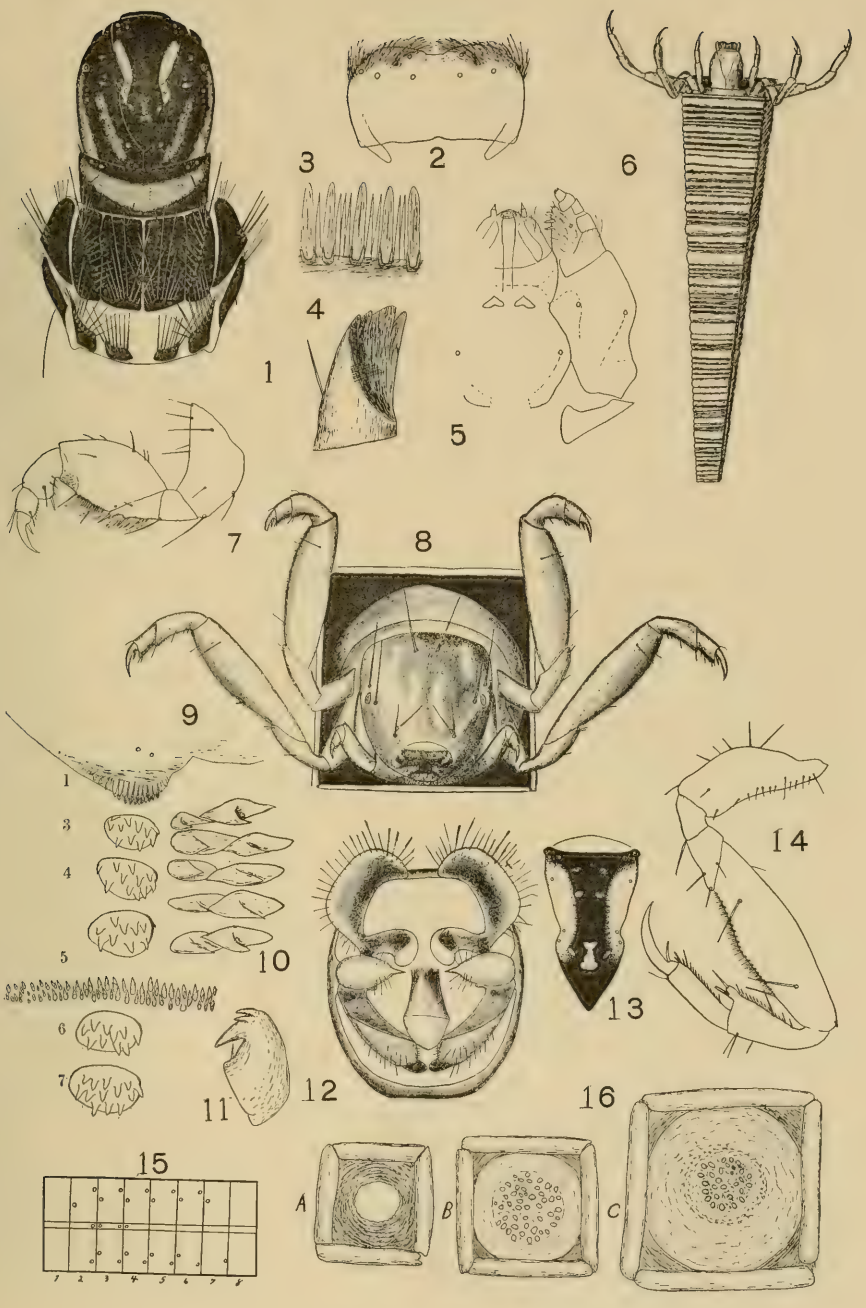
The Case, Fig. 6, is 15-18 mm. long, 3-3.5 mm. wide at its anterior end and about 1.5 mm. wide at its posterior end; it is constructed of minute twigs, root fibers and fragments of wood cut to the proper length to give even and straight edges gradually diverging toward

the anterior end. In cross-section the outer surface of the case is square; the interior is lined with a cylindrical tube of tough silk which is equal in diameter to the inside diameter of the square exterior framework; the spaces between the corners of the square exterior and the silken tube are filled with silk. At the caudal end of the case, Fig. 16*a*, the tube narrows abruptly, leaving a circular opening about one-half mm. in diameter. At the time of pupation, as already mentioned, the sheet of perforated silk, Fig. 16*c*, is placed across the anterior end of the case, and a sheet, Fig 16*b*, is spun about 4 mm. from the caudal end. The case undergoes no other alteration at the time of pupation. So toughly made are these cases that they persist without deterioration from season to season after their occupants have left them.

## EXPLANATION OF PLATE

*Brachycentrus nigrosoma*

Figure 1. Dorsal view of head and thorax of larva.
Figure 2. Labrum of larva; position of setæ indicated by circles.
Figure 3. Part of comb of second leg of larva in detail.
Figure 4. Mandible of larva.
Figure 5. Labium and maxilla of larva, in part.
Figure 6. Larva extending from case in attitude of waiting for prey.
Figure 7. Front leg of larva.
Figure 8. Front view of larva in attitude of waiting for prey.
Figure 9. Dorsal plates of left side of pupa, segments 1 and 3-7.
Figure 10. A group of hooks in detail from second series on segment 5 of pupa.
Figure 11. Drag hook of larva.
Figure 12. Caudal view of genitalia of adult male.
Figure 13. Frons of larva.
Figure 14. Second leg of larva.
Figure 15. Diagram of left side of abdomen of larva showing distribution of gills.
Figure 16. *a.* Caudal end of larval or pupal case; *b.* Caudal pupal sieve; *c.* Front pupal sieve.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# The Eversible Glands of a Chrysomelid Larva, Melasoma lapponica*

GERSON GARB

## Introduction

It is well known that the larvæ of certain insects, notably those of Tenebrionidæ, Paussidæ, Staphylinidæ, Malachiidæ and Chrysomelidæ, possess segmentally arranged eversible glands, which are supposed to be repugnatorial in function. These are highly developed in the genus Melasoma, of the Chrysomelidæ, in which they have been studied by several investigators. In spite of the attention which has been devoted to them, there is no satisfactory modern account of their structure. For this reason, at the suggestion of Professor William A. Riley, I undertook the study of these glands. I used the larvæ of *Melasoma* [*Lina*] *lapponica,* which is very common on the willows about Ithaca. The insects were fixed in Gilson's mercuro-nitric, in Brazil's fluid, and in Flemming's solution. They were cut six and ten microns thick, and those fixed in the first two reagents were stained with Delafield's haematoxylin iron haematoxylin.

## Occurrence of the Glands

The glands of *Melasoma lapponica* are situated in the larva in conical tubercles, which are eighteen in number, and are arranged in two rows along the dorso-lateral portion of the meso- and metathorax and the seven following abdominal segments. The thoracic tubercles are somewhat larger than the abdominal ones and contain proportionally larger glands. They are present during the entire period of the larval stage, disappearing during metamorphosis.

## Historical

The existence of these glands was known to DeGeer (1), who in 1775 figured and described the external features of those of

*Contribution from the Entomological Department of Cornell University.

*Melasoma* [*Chrysomela*] *populi.* He undertook, however, no detailed study of the internal structure. Lyonet (2) also mentions the existence of these glands. It is also noted by Ratzeberg (3).

But the first one to describe the anatomy and histology of these glands was C. Claus (4), who gives an excellent account of those of *Melasoma* [*Lina*] *populi.* Indeed, so detailed and thoroughgoing is his paper that at first sight it appears almost useless to devote further attention to the subject. There are, however, certain points which were misinterpreted by Claus, and others which escaped his attention. These discrepancies are due to the fact that the modern methods of sectioning were not known at that time, and that the glands were studied *in toto,* after dissecting them out. Considering the minute size of the glands, the wonder is not that Claus made the few mistakes to be pointed out, but rather that he did not make many more.

Claus's figures and descriptions have been copied by most later writers, notably by Dimmock (5), Packard (6), and Schroeder (7). Candeze (8) mentions the glands of *Melasoma* [*Chrysomela*] *populi* in his paper, saying that the fluid it secretes has the odor of prussic acid. Berlese (9), while citing Claus, gives different figures, which are evidently original. The most notable features of Berlese's figures are the inclusion of a muscle not figured by Claus and the omission of the muscles which Claus does figure, and the figuring of the little chitinized canal in the secretory glandular cells. As will be pointed out later, both Claus and Berlese are correct in the muscles which they figure, but neither has represented the complete arrangement.

## Observations on the Activity of the Glands in the Living Larva

While rearing the larvæ of the *Melasoma* [*Lina*] *lapponica,* I noticed that when disturbed they ejected a tiny white, pearly droplet from each of the eighteen tubercles already described. The droplets diffused a strong odor, which Professor Riley suggested resembled the odor of prussic acid. A test with litmus paper proved the acidity of the secretion. The droplets remained on the

tubercles only a few seconds, often even less than a second, and then they were withdrawn, mostly (but not always) simultaneously and suddenly into the interior. The larva was capable of discharging its odorous secretion five to six times in succession. An examination of the bead-like droplet under the binocular microscope showed that it was shiny, white, globose and constricted at the base. One larva, from which the disturbing needle was not withdrawn for some time, kept the droplets out for about six to seven seconds at a stretch until some finally burst and the fluid spread over the surface of the body. It could plainly be seen that the broken membrane was quickly withdrawn into the interior. After a few seconds there was another discharge, but this time the droplet was no longer globose nor white, but more or less shapeless and yellowish at the bottom. The fluid this time spread as soon as discharged, while the broken membrane remained for two or three seconds in a shapeless mass on the outside, and was then withdrawn. This was repeated four to five times until the larva was utterly exhausted.

These observations indicated that below the tubercle there was a reservoir full of the secretion, of which only a small portion was discharged each time by eversing only a portion of the reservoir. It was evident that the insect was very economical with its secretion, keeping it out only long enough to diffuse the strong odor, although it had evidently a larger supply of the fluid ready in storage. This economical use of the secretion is mentioned by Claus. How the insect is able thus to economize with the fluid will be evident when the anatomy of the gland is discussed.

As to the function of the strong smelling secretion, it is evident that it is protective, from the fact that it is discharged only when the larva is disturbed, and that it is not present in the adult. Its odor in itself is a strong indication of its protective function.

## Anatomy and Function of Parts

The general structure of the gland and its operation is shown in Figs. 1 and 2, which are slightly diagrammatic. Figure 1 represents the gland in its retracted position. As is shown, the gland consists of a reservoir (R), which is an inpocketing of the cutaneous epithe-

lium. The fluid is secreted by large glandular cells (G l) of which four are shown in this section. The fluid is stored up in the reservoir, which is held in position by two sets of muscles ($M^1$ and $M^2$). Of muscles $M^1$, there are two pairs to each tubercle, one pair being at about right angles to the plane of the other pair. Of muscle $M^2$, there is probably only a single fibre [there is an indication that there is another muscle fibre of $M^2$ at the base of the reservoir, but having failed to trace direct connections in the sections, I am not sure whether it exists]. In this figure, both $M^1$ and $M^2$ are contracted. $M^1$ holds the upper portion of the reservoir [Ep R] contracted within the tubercle. The blood coming in between the hypodermis of the tubercle (H p) and the epithelium of the reservoir (Ep R) at Sp., forces up the portion of the epithelium of the reservoir immediately below the attachment of muscle $M^1$, as at $Ep^1$ R. At this point the walls of the reservoir are thus partially approximated and form a simple means for closing the mouth of the reservoir, thus preventing unnecessary loss of the secretion by evaporation when the gland is at rest. The lower portion of the reservoir is held in place by muscle $M^2$ and in shape by the fluid inside. On the inside of the body the reservoir is bathed by blood and surrounded by a rich supply of tracheæ and fat tissues, which are omitted in this diagram. Fig. 2 shows the gland in its eversed position. The gland is pushed out by blood pressure, resulting from a general contraction of the peripheral body muscles. At the same time, the muscles $M^1$ and $M^2$ relax, the entire reservoir is thus forced forward, but only a small portion comes to the outside. Ep R and $Ep^1$ R, which in Fig. 1 are within the tubercle, are here forced to the outside. Further than this point the epithelium cannot be pushed out, it being held back both by $M^1$ and $M^2$, which have reached the limit of their relaxation. The blood pressure also forces the blood in Sp between Ep R and $Ep^1$ R, tending to give to the eversed portion of the gland its characteristic globose appearance mentioned above. When this portion of the gland is eversed, a droplet of the fluid contained in the reservoir is forced out and spread on the surface of Ep R and $Ep^1$ R, thus providing for a rapid evaporation of the fluid and a quick diffusion of its offensive odor. At the same

time the blood pressure in Sp, which give the eversed portion its characteristic bead-like appearance, also closes the opening of the reservoir by bringing the lips close together, this providing against excessive discharge of the fluid. In this manner the economy, of which Claus speaks, is easily explained. When the gland has been eversed a few seconds, the peripheral muscles of the body relax, the blood pressure is withdrawn, $M^1$ and $M^2$ contract and the gland is brought back to its normal position as in Fig. 1.

The eversion of the gland primarily by blood pressure explains the bursting of the gland mentioned in one of the preceding paragraphs. It also explains the yellowish appearance of the fluid discharged after the bursting, it being now mixed with the blood.

As seen, the function of $M^1$ and $M^2$ is to relax when the gland is eversed and to contract when it is withdrawn. This is in direct contradiction to the statement of Claus, who says that "when these (referring to the set of muscles $M^1$, which is the only set he figures) contract, they bring the movable point of insertion to the relatively fixed one in the tubercle, throw open the closed tubercle and force out the anterior portion of the bag-like, dilated part of the reservoir, from which there comes out a droplet of the secretion." A glance at the relative position of the apex of muscle $M^1$ when the gland is retracted and eversed, as seen in figures 3-4 and figure 8, will prove the incorrectness of Claus's interpretation of the function of this muscle. Berlese, while figuring $M^2$, omits $M^1$. He also fails to explain the function of this muscle or to state how the eversion and retraction of the gland is accomplished.

## Histological Structure

The epithelium of the reservoir is an inpocketing of the hypodermis, and consequently consists of a layer of cells lined with chitin. The cells are much smaller than the cells of the hypodermis, and are very irregular. (Fig. 12.) They are flattened and broad at the base and more or less pointed towards the chitinous intima. The nucleus is relatively large, occupying the greater part of the cell body, and is coarsely granulated, staining quite deeply. The cytoplasm, on the other hand, is very finely granulated. Lying close to

the cells and following the irregular folds and wrinkles presented by these, there is the chitinous intima (Fig. 3). On the other side of the cell layer, there is the basement membrane, which is likewise a continuation of the basement membrane of the hypodermis. The basement membrane is continuous over the surface of the glandular cells. The epithelial cells of the reservoir appear to be syncytial, as mentioned by Claus, but I believe that this is due to the fact that they are so small and attenuated at their base. I believe that with proper fixers and stains the distinctness of the cells may be proven. Indeed, in the sections which I have examined, there are indications that this is the case. The shape of the epithelial cells of the reservoir is another illustration of the adaptability of the body tissues to meet their special demands. One would certainly expect such a shape of cells in a layer which is subject to frequent folding and unfolding, as is the epithelium of the reservoir.

The structure of the glandular cells is somewhat more complicated. Usually they are round, but owing to the blood pressure, they often assume an oval and even a polyhedral form. Three such glands are seen in Figs. 9-11. Figs. 9 and 10 are of two glands of the same larva, which has been fixed in Gilson's Fluid and stained with haematoxylin and eosin, while Fig. 11 is from a larva fixed in Flemming's solution and stained with iron haematoxylin. In the center of the gland there is a very large, deeply staining nucleus (N). Usually this is round, but it may often be oval. It is very coarsely granulated throughout, with still larger granules scattered here and there. Figs. 9-10 show no vacuoles at all in the nucleus, while in Fig. 11 the nucleus has small vacuoles. The cytoplasm has a very granulated ground substance in which are imbedded large, red, shining granules (Figs. 9-10, Gr.), which are probably part of the oily secretion. In Figs. 9-10 the cytoplasm is much vacuolated, the vacuoles being bridged over by many irregular strands which connect the various processes of the cytoplasm. In Fig. 11, the cytoplasm is not vacuolated except for a small vacuole half way between the apex of the nucleus and the top of the cell. In this vacuole ends the chitinous little canal (C l) through which the secretion reaches the reservoir. This chitinous canal is a con-

tinuation of the intima lining the epithelium of the reservoir and extending over the mouth of the glandular cell, reaching down into the interior to the vacuole. Surrounding this little canal there are two guard cells which are distinguishable by their nuclei ($N^1$). It is possible that the function of the guard cell is to secrete the chitin lining the little canal.

The vacuolated condition of the cytoplasm in Figs. 9-10 is probably due to the fact that the fixer has dissolved out the secreted fluid which fills these vacuoles, leaving only the large granules (Gr.), while in Fig. 11 the fluid has been coagulated by Flemming's solution.

Owing to lack of time, it has been necessary to omit the study of the gland in the pupa. Claus states that the reservoir is retained in the larval skin, in which the lower portion of the pupal body is enclosed. According to him, the pupa is still able to discharge droplets of the secretion by wriggling vigorously when disturbed. This point demands further investigation.

The size of the glandular cells varies between 75 and 87 mm. Claus gives their number in *Melasoma* [*Lina*] *populi* as thirty to forty-five for the thoracic and twelve to twenty for the abdominal glands. In *Melasoma lapponica,* on the other hand, I have found only fifteen in the thoracic glands and seven in the abdominal ones.

The size of a thoracic gland in its retracted state is about 0.75 mm. in its longest axis, including the glandular cells, and about 0.30 mm. at its base. The abdominal glands are about two-thirds the size of the thoracic ones.

As to the chemical composition of the secretion, no attempt was made to establish anything beyond the fact that it is acid reacting. Neither was there any attempt to work out the nerve supply.

In conclusion, I wish to express here my sincerest gratitude to Professor William A. Riley, under whose supervision this has been worked out, for his kind encouragement and instructive criticism, without which this work would have been impossible.

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## LEGENDS

Figure 1. Semidiagrammatic representation of the gland in its retracted position. Pr. c., primary cuticula; Sc. c., secondary cuticula; Hp., hypodermis; Ep. R. and Ep. $^1$R., epithelium of the reservoir; Gl, glandular cells; Sp., space between hypodermis and epithelium of reservoir where blood is forced in; $M^1$ and $M^2$, musculature of the reservoir.

Figure 2. Gland in its eversed position.

Figures 3-12 are drawings of section of gland. In all these the chitin is seen torn away from the hypodermis, due to shrinkage of the latter in the processes of sectioning. Wherever the hypodermis is seen more than one layer thick, it is because the section at this point has been cut tangentially, close to the surface.

Figure 3. Longitudinal section of a thoracic tubercle with the gland inside. R., reservoir; W. bd., wing bud; In., intima; Ep. F., epithelial fold, caused by blood pressure against retention of muscle $M^1$; Trg., Trichogen cell; Tr., trachea; Ep 2, piece of epithelium torn away from Ep 1; the rest as in Fig. 1.

Figure 4. Section following that of Fig. 3.

Figure 5. Section following that of Fig. 4.

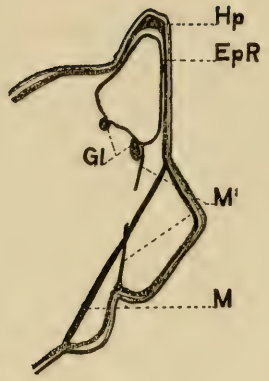
Figure 6. Section at right angles to plane of Figs. 3-5, showing attachment of muscle $M^1$. $R^1$ and $R^2$, portions of folds of reservoir; $Ep^1$ and $Ep^2$, sections through longitudinal fold of epithelium; M, peripheral body muscle.

Figure 7. Section in same plane as Fig. 6, showing muscle $M^2$; M, peripheral body muscle; $M^2$, muscle of reservoir.

Figure 8. Section in same plane as 7, showing position of muscle $M^1$, where gland is eversed; T, top of tubercle.

Figures 9, 10 and 11. Glandular cells. N, nucleus; $N^1$, nucleus of guard cell; $C^1$, chitinous canal; Gr. granules.

Figure 12. Portion of the epithelium of the reservoir. Ep R, epithelial cells; I, intima.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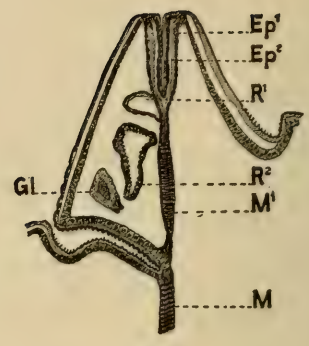
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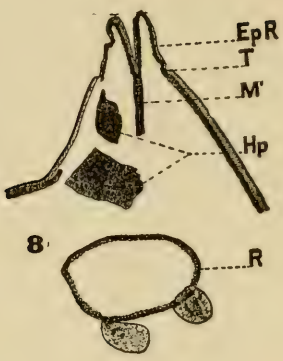
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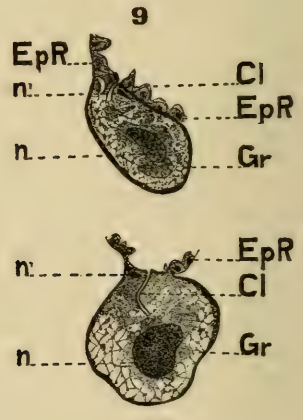
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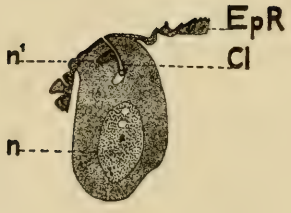
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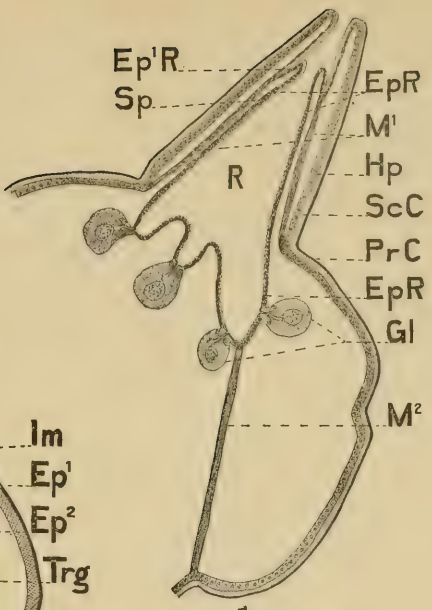
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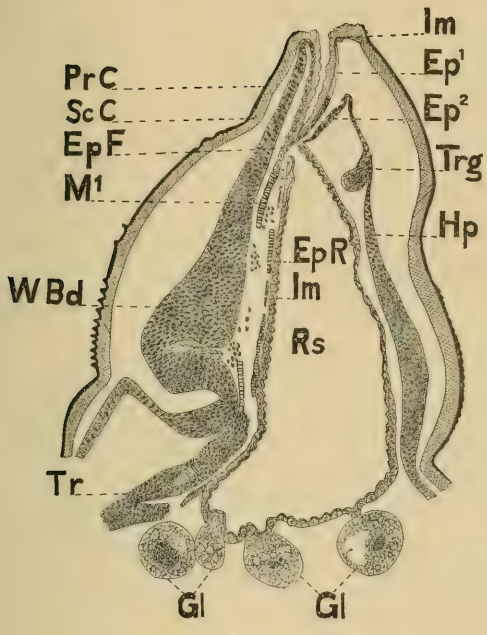
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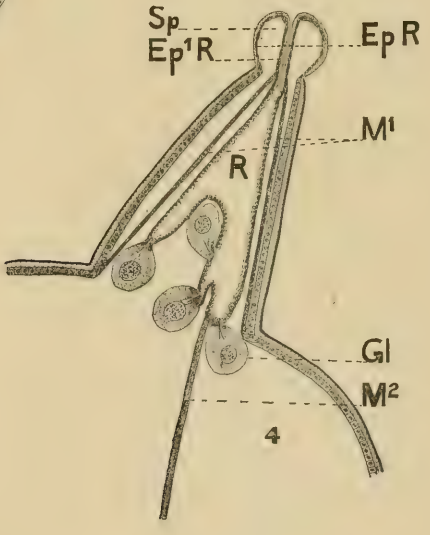
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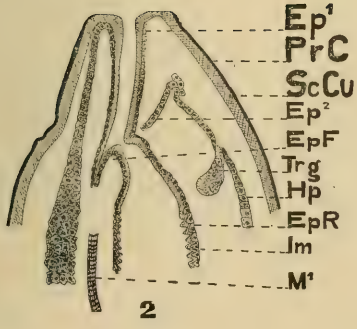
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2

# Homology of the Mouth-Parts of the Preimago in the Lepidoptera*

EDNA MOSHER

There has always been more or less discussion as to the presence or absence of mandibles in the Lepidoptera. Some writers have argued that mandibles are present only in rare instances and that the structures thought to be mandibles are generally pillifers. Since Poulton's studies on the pupal wings of Lepidoptera have shown that a more generalized outline is always present than in the case of the imago, and Spuler has called attention to the fact that the veining in pupal wings is much more generalized than in the imago, it seemed highly probable, therefore, that a study of the preimago might throw some light on the question of the presence of mandibles and the homology of the mouth-parts in this order. Representatives of nine genera were studied for this purpose and the results of the investigation are given herewith.

## Sthenopis thule

A study was first made of the mouth-parts of three forms selected from widely differing families. The first, *Sthenopis thule,* an hepialid, belongs to a very generalized family of Lepidoptera, where it would be expected that all of the parts represented in any family of the order would be present. Although the adult mouth-parts are functionless, the parts are all present in the preimago and the clypeus, labrum, mandibles, maxillary lobes which are doubtless the homologues of the maxillæ of other members of the order, maxillary palpi and labial palpi are easily identified. In a cephalic view of *Sthenopis thule* (Fig. 1) the clypeus (Fig. 1, cl) is shown occupying the central portion of the head, strongly concave on the margin adjoining the labrum, with the caudo-lateral angles produced, and rounded, the invaginations for the anterior arms (Fig. 1, at) of the tentorium being located between these

*Contribution from the Entomological Laboratories of the University of Illinois, No. 39.

angles and the labrum. There is a distinct oval tubercule near the caudal margin of the clypeus and it is more strongly chitinized than the labrum. The clypeo-labral suture is distinct, the labrum (Fig. 1, lb) slightly convex on its distal margin, the length and breadth approximately equal. Laterad of the labrum and apparently articulating with the caudo-lateral angles of the clypeus are functionless mandibles (Fig. 1, md), the suture between these mandibles and the genæ being very distinct. Caudad of the mouth-cavity is the mentum (Fig. 1, m), bearing a pair of two-segmented labial palpi covered with setæ and laterad of its proximal margin on each side is a maxillary lobe (Fig. 1, ml). Each of these lobes consists of three segments, a long proximal segment and two shorter distal ones. A ventral view of the head (Fig. 2), shows a distinct suture between the submentum and mentum and on the lateral margin, near the proximal end of each maxillary lobe is a short maxillary palpus (Fig. 2, mp).

### Archips argyrospila

Later, *Archips argyrospila,* a tortricid, whose mouth-parts are functional in the adult, was considered, and the same parts were found to be present. The clypeus is well defined (Fig. 3, cl), the clypeo-labral suture distinct and the margin slightly convex adjoining the labrum. The invaginations for the anterior arms of the tentorium (Fig. 3, at) are very distinct and located along the lateral margins of the clypeus. The labrum is well developed, much wider than long, with distinct pillifers (Fig. 3, pf) at each disto-lateral angle, bearing long setæ along their mesal margins. The distal margin of the labrum has a distinct tooth at the meson and below it may be seen the epipharynx (Fig. 3, ep), projecting tongue-like from beneath the labrum. In order to be sure of the homology of this part, a preparation was made of the clypeus and labrum of a preimago of *Protoparce sexta,* which shows a similar projection from beneath the labrum. The ental surface of the cephalic aspect of the head (Fig. 5) shows the distal margin of the labrum indicated by a dotted line. The projecting part of the epipharynx (Fig. 5, ep) is shown to be continuous with that lining the ental surface

of the clypeus and labrum. Just proximad of the line indicating the distal margin of the labrum is a more or less triangular, slightly chitinized area. Laterad of this slightly chitinized area on each side is a group of sensory pits (Fig. 5, sp). At the right is shown the anterior arm of the tentorium (Fig. 5, at). The fulcrum is seen as a narrow, chitinized T-shaped rod on each side fastened at base to the anterior arm of the tentorium (Fig. 5, fu). Proximad of the T-shaped fulcrum there is, on each side, a thinly chitinized quadrangular area which narrows to a point mesad of the fulcrum. The dotted lines at the proximal end indicate the proximal end of the pharynx. The arrangement of these parts is very similar to that found in such mandibulate insects as the cockroach and grasshopper. Laterad of the labrum (Fig. 3, md) at each proximolateral angle between the clypeus and labrum is a thin, colorless appendage, undoubtedly a mandible. The maxillæ of *Archips* are well developed, more than twice the length of the head, the two parts lying closely approximated so that they can be fitted together to form a tube. The distal half of each maxilla (Fig. 3, mx) has a number of fine short setæ along the lateral margin. Beneath the maxillæ may be seen the labial palpi (Fig. 3, lp), which are slightly wider than the maxillæ, about half their length and densely covered with fine setæ. In a ventral view (Fig. 4) there may be seen, attached to the lateral margin at the base of the maxilla, on the side from which the labial palpus has been removed, a slender four-segmented maxillary palpus (Fig. 4, mp). Each maxillary palpus extends laterad towards the antenna, then is directed cephalad until it reaches the ventral surface where it bends mesad and lies closely appressed to the caudal margin of the eye and is seldom seen in cephalic view.

### Hemerocampa leucostigma

The next form considered was *Hemerocampa leucostigma,* a liparid. In this form the adult mouth-parts are functionless, but in the preimago the parts found in the previous forms were all present, the mandibles (Fig. 12, md) being much more distinct and mandible-like than in either *Sthenopis* or *Archips* and leaving no doubt as to their identity. The clypeo-labral suture is obsolete and

the invaginations for the anterior arms of the tentorium (Fig. 12, at) are larger and more prominent than in the forms previously considered and located along the lateral margin of the clypeus. The mandibles are four-toothed and heavily chitinized. Mesad of these are the maxillæ (Fig. 12, mx) which are shorter than the head, rather broad at base, with a distinct projection on each lateral margin but showing no traces of maxillary palpi. The labial palpi (Fig. 12, lp) show on each side the meson between the two halves of the maxillæ, the proximal segments larger than the distal ones, which are globular in the pupa, but ovoid in the preimago.

Following these a study was made of the mouth-parts of six genera of the superfamily Saturnioidea. These showed little variation and were very similar to the mouth-parts of *Sthenopis thule* and *Hemerocampa leucostigma* for, like these species, the mouth-parts are functionless in the adult. It was noticed in all these forms that the appendages were much more distinct in pupæ than in the preimagos. The mandibles, which in the adult seem but projections from the genæ, are plainly appendages in the pupa with the proximal suture distinct and also the articulation with the clypeus. The latter can not be seen in the preimago, but the proximal suture is usually distinct, the mandible being more heavily chitinized and more plate-like in this stage. The maxillæ show much difference in the stages of their development, being larger at first and usually more closely approximated in the younger stages, gradually becoming contracted and farther apart in the preimago. The maxillæ show varying degrees of development in the different genera. Maxillary palpi were not found in all the genera studied, but lack of material prevented a study of the earlier stages of some forms and it may be that further study would show them to be always present. In every case there is a projection at the base of each maxilla, where the palpi are located when present.

The labial palpi are always present and show about the same degree of development, although the number of segments varies in different species.

The six genera of Saturnioidea studied are as follows: *Citheronia regalis, Dryocampa rubicunda, Automeris io, Telea polyphemus, Callosamia promethea* and *Samia cecropia.*

### Citheronia regalis

This form (Figs. 6 and 8) shows a decided, transverse projection on the clypeus, probably about the place where it is joined to the labrum, although the clypeo-labral suture is indistinct. The invaginations for the anterior arms of the tentorium are small and located at either end of the transverse ridge. The labrum (Fig. 6, lb) is slightly convex at the proximal margin, concave at the distal margin and its width is less than twice the length. The mandibles could not be clearly distinguished in the specimen at hand, but as it had emerged from the pupal skin they were doubtless so fused with the genæ as to be indistinguishable. The maxillæ (Fig. 6, mx) are not as long as the head and are slender with each half the maxillæ tube-like, tapering to a point at the distal end, where they are strongly recurved. The labial palpi (Fig. 6, lp) are large and prominent, two-segmented, the distal segment porrect, and the whole appendage densely covered with setæ.

### Dryocampa rubicunda

In this form (Figs. 7, 11 and 13) there is a distinct suture between the clypeus (Fig. 13, cl) and labrum (Fig. 13, lb), with the invaginations for the anterior arms of the tentorium located at each end. The portion of the clypeus adjoining the labrum is elevated into a prominent transverse ridge similar to that in *Citheronia regalis*. The labrum is convex along its proximal margin, concave on its distal margin, considerably elevated above the surface of the clypeus and much wider than long. Laterad of the labrum are structures which have every appearance of being functionless mandibles (Fig. 13, md). They have a distinct suture at the proximal end and are quite heavily chitinized along the distal margin, but not toothed. The maxillæ (Fig. 13, mx) are very small and lie adjacent on the meson, the distal ends pointed and projecting slightly cephalad. The labial palpi (Fig. 13, lp) are slightly longer than each half of the maxillæ, clavate, and covered with long setæ, more numerous on the lateral margin.

### Automeris io

This species (Figs. 9, 10 and 17) has the distal margin of the clypeus elevated into a prominent transverse ridge which projects much farther cephalad than similar ridges in *Citheronia regalis* and *Dryocampa rubicunda*. The clypeo-labral suture is obsolete. The invaginations for the anterior arms of the tentorium (Fig. 17, at) are large and prominent and located along the lateral margins of the labrum. The labrum (Fig. 17, lb) is quadrangular in outline, much wider than long, the caudo-lateral angles slightly produced and rounded. Laterad of the labrum are the functionless mandibles (Fig. 17, md), the proximal suture distinct and the distal margins heavily chitinized. The maxillæ (Fig. 17, mx) are small, somewhat oblong in outline and meet on the meson. They bear a few long setæ on the lateral margin, which extend the whole length of the appendage. The labial palpi (Fig. 17, lp) are very large and prominent, three-segmented and thickly covered with setæ.

### Telea polyphemus

In *Telea polyphemus* (Figs. 14, 19 and 23) the mouth-parts are very distinct and leave no doubt as to their homology. The clypeus (Fig. 14, cl) is heavily chitinized, strongly concave with the labrum fitting into the concavity, with the corners of the clypeus produced into a rounded angle on each side of it. The labrum (Fig. 14, lb) is narrow, much wider than long with its distal margin irregularly corrugated. The invaginations for the anterior arms of the tentorium (Fig. 14, at) are very prominent and located along the lateral margins of the clypeus. Laterad of the clypeus and labrum on each side is a well developed mandible (Fig. 14, md), each strongly chitinized and slightly toothed on the distal margin and projecting slightly cephalad. The maxillæ (Fig. 14, mx) are fairly well developed, slightly longer than the head. Each half has a prominent lateral projection near the base, but no trace of a maxillary palpus could be found. The maxillæ are slightly separated at the proximal end but lie adjacent on the meson for about three-fourths their length, tapering gradually to a point at the distal end. The labial palpi (Fig. 14, lp) are more than half

as long as the maxillæ, cylindrical in outline, broadly rounded at the distal end and covered with setæ which are longer along the mesal margins.

### Callosamia promethea

This form (Figs. 15, 18 and 22) has a strongly chitinized clypeus, with the invaginations for the anterior arms of the tentorium (Fig. 18, at) very prominent, and located at its ventro-lateral angles. The clypeo-labral suture is distinct, the labrum (Fig. 18, lb) slightly concave along its distal margin and its width much greater than the length. Laterad of the labrum on each side are functionless mandibles (Fig. 18, md), heavily chitinized along their mesal and caudal margins, the mesal margin irregular, but not distinctly toothed, the proximal articulation having been lost. Caudad of the mandibles there is a pair of maxillæ (Fig. 18, mx), separated by a distance equal to the width of the labrum. The proximal part of each maxilla is conical and bears a short but well defined two-segmented maxillary palpus (Figs. 18 and 15, mp) which is more heavily chitinized than the basal part of the maxilla. The distal portion of the maxilla (Fig. 15, mx) is triangular in outline and is directed cephalad, the margin chitinized and distinctly serrate. Caudad of the maxillæ and slightly nearer the median line are a pair of clavate labial palpi (Fig. 18, lp), the proximal part chitinized at their point of attachment, the distal portion covered with setæ, as long or longer than the appendage itself. The mentum and submentum (Fig. 22, sm and m) are fused, strongly chitinized, and bear two short setæ on each side of the meson near the proximal margin. At the base of each maxilla is located an invagination for the posterior arms of the tentorium.

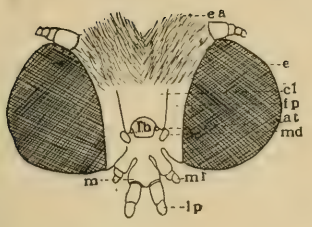
### Samia cecropia

This species (Figs. 16, 20 and 21) has the clypeus (Fig. 21, cl) strongly chitinized especially along the margin adjacent to the labrum. The invaginations for the anterior arms of the tentorium (Fig. 21, at) are very large, oval in outline, and located along the lateral margin of the clypeus. The clypeo-labral suture is distinct

and the labrum less heavily chitinized than the clypeus. The labrum (Fig. 21, lb) is slightly concave on its distal margin, much wider than long, and bears on each side the meson, near the cephalic margin, a number of prominent setæ, whose number appears to vary from two to six according to the age of the pupa. Laterad of the labrum on each side are the mandibles (Fig. 21, md) which were not heavily chitinized in the pupæ first examined, but the margin was irregular and the proximal articulation was distinctly seen. Later stages showed the mandibles more heavily chitinized and the mesal margin more distinctly toothed, but the proximal articulation much less distinct. Caudad of the labrum, and separated by a distance equal to one-third the width of labrum, is a pair of well developed maxillæ (Figs. 16 and 21, mx). They are elongate, the length more than twice the width, with a prominent projection on the lateral margin bearing a small maxillary palpus (Fig. 16, mp) having a group of long setæ. In older pupæ the maxillæ were much shorter and somewhat broader, so they are more or less rounded, and closely approximate each other on the median line. Caudad of the maxillæ are the labial palpi, which are globular or ellipsoid and very little longer than broad. The labial palpi (Fig. 21, lp) are covered with setæ considerably longer than the appendage and are slightly chitinized at the base and distal end. The mentum and submentum (Fig. 20, sm and m) are distinct in this species, the latter being heavily chitinized. At the base of each maxilla may be seen an invagination for the posterior arms of the tentorium (Fig. 20, pt).

## EXPLANATION OF PLATES

Figure 1. Cephalic view of the mouth-parts of a preimago of *Sthenopis thule.*
Figure 2. Ventral view of the mouth-parts of a preimago of *Sthenopis thule.*
Figure 3. Cephalic view of the mouth-parts of a preimago of *Archips argyrospila.*
Figure 4. Ventral view of the mouth-parts of a preimago of *Archips argyrospila.*
Figure 5. Ental surface of the cephalic aspect of the head of *Protoparce sexta.*
Figure 6. Cephalic view of the mouth-parts of a preimago of *Citheronia regalis.*
Figure 7. Lateral view of the mouth-parts of a preimago of *Dryocampa rubicunda.*
Figure 8. Lateral view of the mouth-parts of a preimago of *Citheronia regalis.*
Figure 9. Lateral view of the mouth-parts of a preimago of *Automeris io.*
Figure 10. Ventral view of the mouth-parts of a preimago of *Automeris io.*
Figure 11. Ventral view of the mouth-parts of a preimago of *Dryocampa rubicunda.*
Figure 12. Cephalic view of the mouth-parts of a preimago of *Hemerocampa leucostigma.*
Figure 13. Cephalic view of the mouth-parts of a preimago of *Dryocampa rubicunda.*
Figure 14. Cephalic view of the mouth-parts of a preimago of *Telea polyphemus.*
Figure 15. Lateral view of the maxilla of a preimago of *Callosamia promethea.*
Figure 16. Lateral view of the maxilla of a preimago of *Samia cecropia.*
Figure 17. Cephalic view of the mouth-parts of a preimago of *Automeris io.*
Figure 18. Cephalic view of the mouth-parts of a preimago of *Callosamia promethea.*
Figure 19. Ventral view of the mouth-parts of a preimago of *Telea polyphemus.*
Figure 20. Ventral view of the mouth-parts of a preimago of *Samia cecropia.*
Figure 21. Cephalic view of the mouth-parts of a preimago of *Samia cecropia.*
Figure 22. Ventral view of the mouth-parts of a preimago of *Callosamia promethea.*
Figure 23. Lateral view of the mouth-parts of a preimago of *Telea polyphemus.*

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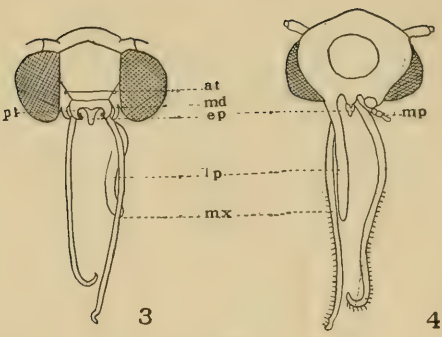


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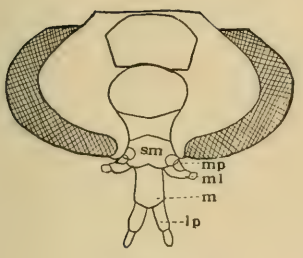


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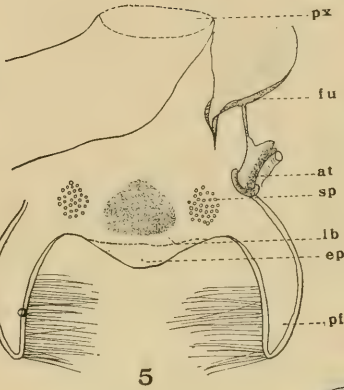


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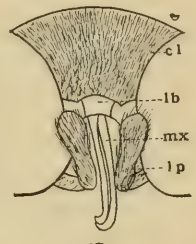


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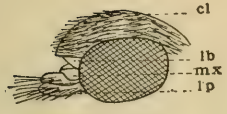


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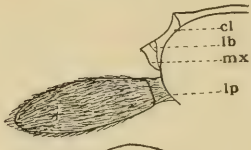


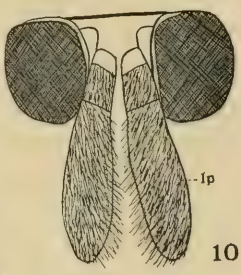


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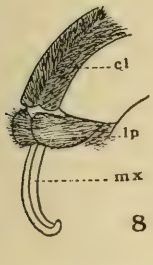


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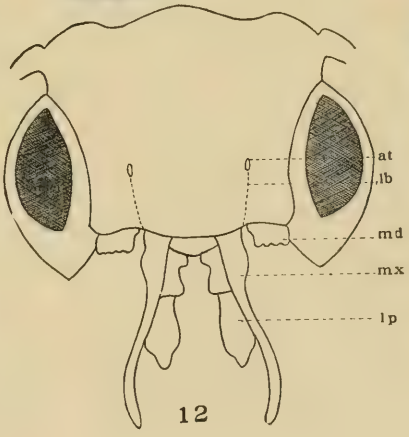


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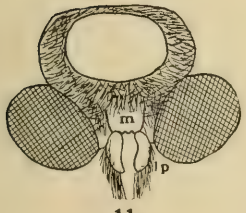


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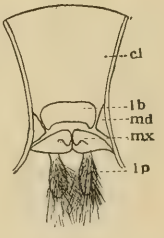


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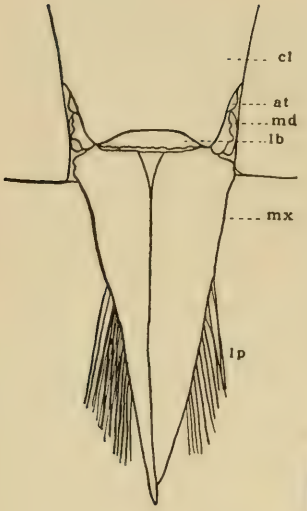


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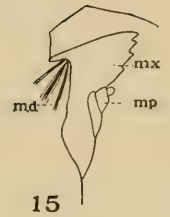


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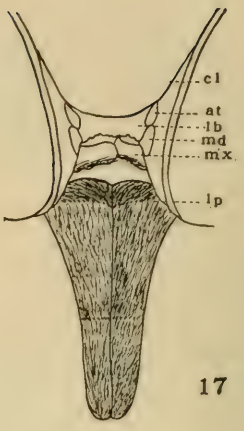


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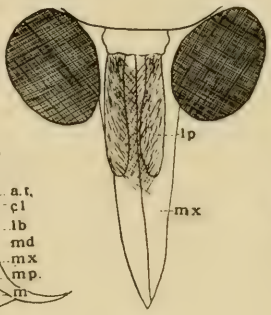


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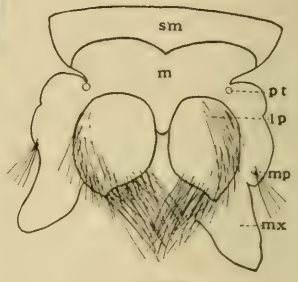


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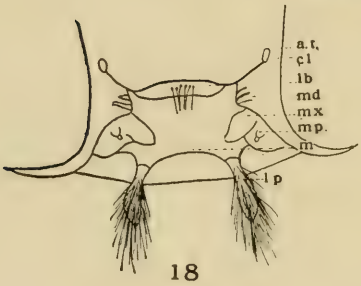


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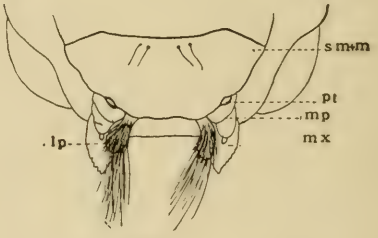


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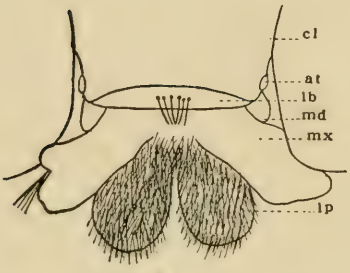


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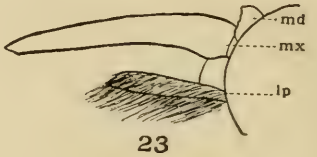



23

# New Genera and Species of North American Hemiptera

By E. P. Van Duzee
University of California, Berkeley, Cal.

The following new genera and species of Hemiptera are published now so the names may be included in a forthcoming check list of the North American Hemiptera.

*Cnemodus inflatus* n. sp.

A little longer and darker than *mavortius,* with the rostrum shorter and the anterior lobe of the pronotum more inflated. Length 9-10 mm.

Piceous black, impunctate. Elytra dark castaneous with a pale costa; legs, antennæ and rostrum honey-yellow. Head as in *mavortius,* the antennæ a little paler, with the tip of the third and the whole of the fourth joint fuscous. Rostrum attaining the insertion of the anterior feet, the extreme tip black. Pronotum stout, anterior lobe strongly inflated, ovate, much wider than the posterior lobe and fully as wide as the broadest part of the closed elytra; collar narrow but distinct as in *mavortius;* posterior lobe but slightly developed, flat, scarcely flaring and not at all elevated behind; lateral margin tumid, posterior feebly arcuated; surface rugulose, dark castaneous. Scutellum piceous black becoming castaneous at the acute apex, surface irregularly punctured, with a very obscure median carina. Elytra dark castaneous, coarsely but sparsely punctured, costa pale to beyond the middle, the extreme base sanguineous where covered by the humeri. Membrane rudimentary, the nervures scarcely indicated. Legs pale castaneous or honey-yellow, becoming whitish basally; anterior femora thicker than in *mavortius,* similarly armed with about six spines, its tibiæ strongly curved at base as far as the long arcuated spine which is placed nearer to the base than to the apex; all the tibiæ blackish. Beneath dark castaneous becoming blackish on the pleuræ; the stigmata and connexivum almost sanguineous.

Described from two brachypterous males from North Carolina: one taken by Mr. W. J. Palmer of Buffalo on Balsam Mountain; another taken by Mr. Manee at Southern Pines, and four examples received from Mr. H. G. Barber.

I have seen both sexes of both this species and *mavortius,* and there is no doubt but they are distinct even should there be a question which is the true *mavortius* of Say. I am convinced that *brevipennis* H. S. and *alacris* Walker are the same as Say's species, and that all refer to the smaller form which has the anterior lobe of the pronotum sub-cylindrical and narrowed anteriorly, the rostrum attaining the insertion of the intermediate feet and the base of the ultimate antennal joint frequently paler. It is probable that in this as in the allied species the macropterous examples have the posterior lobe of the pronotum more developed and flaring, so that character in the above description should not be considered as of specific value.

*Opisthuria clandestina* n. sp.

Color light red or orange-red; eyes, antennæ, legs, tip of the abdomen and elytra black; the costa broadly pale. Head before more or less infuscated, the dark color usually covering the vertex, front and clypeus. Antennæ black; basal joint a little longer than the greatest length of the head; second about one-half longer than the first; third a little shorter than the second; fourth two-thirds the length of the third. Loræ separated from the cheeks by a distinct suture. Pronotum deeper red, immaculate; collar longer than the callosities and very convex. Scutellum with a dark red shade covering its basal disk; the anterior lobe covered by the pronotum. Elytra with the costa considerably expanded beyond its basal one-third; black, with a broad whitish costal vitta, which may become fulvous or even red, but is always paler than the pronotum; this pale costal vitta covers the cuneus excepting only its inner margin. Legs black with the coxæ, trochanters and base of the femora pale. Venter red with the genital segments black in both sexes.

Described from numerous examples taken by me at Crescent City, Sanford and Fort Myers, Florida, in April and May, 1908. This species is No. 143 in my report on Florida Hemiptera published in

1909 and was listed as "Resthenia sp." It differs from Reuter's description of his genus *Opisthuria* only in having the loræ well distinguished from the lower cheeks and the base of the scutellum covered, but these characters alone would scarcely seem sufficient for the establishment of a new genus.

*Creontiades debilis* n. sp.

Smaller and slighter than *rubrinerve;* pale yellowish-testaceous with the tibiæ more or less green. Length 6 mm.

Head about as in *rubrinerve,* but with the vertex more prominent before and separated from the clypeus by a very deep incision. Basal joint of the antennæ stout, fusiform, the remaining joints more slender, subequal in thickness. Pronotum proportionately broader, the costa very slightly arcuated. Rostrum attaining the apex of the hind coxæ. Color a pale yellowish-testaceous or almost whitish, with a faint tinge of green in places, especially on the tibiæ and tarsi and on the commissural nervure of the elytra; extreme apex of the scutellum fuscous. Eyes and tarsal claws brown; apex of the rostrum black.

Described from two females and one mutilated specimen taken on Tybee Island, Georgia, July 26th, 1913, by Prof. J. C. Bradley. At Estero, Florida, I took one male, which differs only in being a little stouter and more opaque, with the vertex, base of the antennæ and the pronotum touched with sanguineous and the tip of the scutellum concolorous, not fuscous as in the types. In this male the tibiæ and tarsi are green, as in the type female, and I believe it will prove to be the male of this species. It is possible the type females may be somewhat teneral.

*Platylygus* n. gen.

Closely allied to *Camptochilella* Reut., but with the head longer and more porrect.

Body oblong, polished; head and scutellum minutely transversely rugose; pronotum and elytra punctate. Head produced, strongly oblique; one-half as wide as the base of the pronotum; anterior pronotal angle at the middle of the eyes; viewed from above the head is but little shorter than the pronotum, its length about equal to its

width; viewed from the side it is produced beyond the eye for about the length of the eye; facial angle less than a right angle. Vertex opaque, obliquely striate, with a longitudinal sulcus, distinct at base; base of the vertex slenderly carinate and a little angled at the middle. Clypeus distinctly prominent, strongly distinguished from the front; jugæ convex, almost tumid; loræ convex, distinguished by a slight suture below the antennæ; gula short, oblique. First antennal joint surpassing the clypeus by one-half its length; second scarcely thinner at apex; third and fourth together about two-thirds the length of the second and distinctly thinner, but scarcely setaceous. Pronotum distinctly transverse, moderately sloping; hind margin feebly sinuated; sides straight with a smooth carina; anterior with a slender smooth collar; callosities prominent, contiguous, nearly attaining the anterior margin, posteriorly with an angular emargination between them. Basal lobe of the scutellum a little exposed. Elytra surpassing the abdomen, parallel or nearly so; cuneus long, nearly horizontal; fracture small; smaller areole of the membrane unusually large. Prosternal xyphus conspicuously margined. Rostrum long, reaching the apex of the second ventral segment. Hind tarsi long, second joint on its lower margin distinctly shorter than the first. Arolia small, widely divergent.

This genus differs from *Lygidea* by the longer first joint of the hind tarsi, the more produced and subhorizontal head, opaque vertex with an angled basal carina, longer basal joint of the antennæ, longer rostrum, more slender pronotal collar and the more irregular and distinct pronotal puncturation. It is nearer *Camptochilella,* but the much longer and more horizontal head, the more opaque vertex, the more distinct incisure between the clypeus and vertex, the longer rostrum, the approximate callosities and the longer first joint of the hind tarsi will distinguish it.

Type: *Lygidea rubecula* var. *lurida* Reut., 1909 (founded on Reuter's unique type specimen now in my collection).

*Diplozona* n. gen.

Closely allied to *Cimatlan* Dist. Body small, polished; coarsely punctured; antennæ incrassate.

Head nearly horizontal, considerably produced, surpassing the eye by nearly the width of the eye below. Vertex opaque, transversely rugose, longitudinally sulcate on the middle line; base ecarinate; clypeus but moderately prominent, rather strongly arcuated, scarcely distinguished from the front at its base; cheeks prominently convex; gula horizontal; facial angle less than a right angle. Eyes oblong-ovate, a little oblique, scarcely sinuated before. Antennæ inserted close to the eye and much below its middle; much thickened and clothed with short stiff hairs; first joint short, oblong, abruptly narrowed at its base, surpassing the clypeus by a little more than half its length; second joint about as long as the pronotum, distinctly clavate, its apex being thicker than the first joint; third and fourth fusiform, as thick as the apex of the second, the anastomoses very slender. Rostrum slender, attaining the apex of the intermediate coxæ. Pronotum transverse, strongly narrowed before, the anterior angles a little prominent, attaining the middle of the hind margin of the eyes; hind margin strongly arcuated, covering the basal lobe of the scutellum; sides carinated and a little sinuated; apex with a broad and prominent collar; surface rather convex and with the propleura strongly deeply punctured. Callosities oval, prominent, distant but connected by a raised smooth area anteriorly. Prosternal xyphus distinctly convex with a slenderly carinate margin. Scutellum broader than long, moderately convex, strongly punctured. Elytra moderately convex, strongly punctured; cuneus considerably deflexed; membrane biareolate, surpassing the abdomen by about one-half its length. Second joint of the tarsi much shorter than the first and third. Arolia as in *Camptobrochis,* short and broad, lying against the base of the long curved claws. Oviduct of the female long; reaching well toward the base of the venter.

This genus is closely related to *Cimatlan* but differs in the thickened antennæ and the convex xyphus. It bears a strong superficial resemblance to *Camptobrochis* but may be at once distinguished by the opaque, sulcate vertex and the stout antennæ.

Type of genus, *Diplozona collaris* n. sp.

I might add here that for the present I am unable to find any characters by which to distinguish genus *Eustictus* Reut. from

*Cimatlan* Dist. I would also add that it seems to me necessary to separate *Camptobrochis, Deræocoris,* and their allies, in a distinct division, *Deræocoraria,* of the tribe Capsini. This division may be distinguished by having the arolia short and united with the base of the claws or at times nearly or quite wanting, and usually there are two approximate, straight, parallel setæ between the bases of the claws which might be mistaken for arolia. I am unable to find that Reuter has mentioned the form of the arolia in any of these genera but on the contrary has seemed to consider the free divergent arolia as characteristic of the Capsini. The species in this division have a polished, usually convex body, strongly punctured above, with a small head and a decided tendency to an uniareolate membrane and convex and ecarinate xyphus, thus leading to the Bryocorinæ with which they are almost certainly related.

*Diplozona collaris* n. sp.

Aspect of *Camptobrochis nebulosus* Uhl. Testaceous varied with piceous-brown. Length 4 mm.

Vertex nearly quadrate; pale with a broad median fuscous cloud including a short pale line above the base of the clypeus; eyes black. Basal joint of the antennæ piceous; second pale with the clavate apex rufous and the extreme base fuscous; third and fourth piceous. Pronotum largely fuscous, the posterior submargin and humeral angles pale, the carinate edges whitish; three pale spots on the disk, more or less confluent, and a transverse anterior band covering the callosities pale tinged with fulvous. Exterior angles of the scutellum and a short median line posteriorly pale. Clavus and disk of the corium posteriorly infuscated; embolium hyaline and impunctate, with a rufous spot at its apex; apex of the cuneus fuscous; punctures of the whole upper surface fuscous. Membrane with a faint longitudinal cloud on either side toward the apex, the nervures heavy and piceous. Beneath pale, the propleuræ and sides of the venter dark or piceous; the tibiæ broadly biannulate with fuscous, at least on the hind pair.

Described from one pair taken at Punta Gorda, Fla., November 13, 1911, and received from Mr. H. G. Barber, and two females taken by me at Estero, Fla., in May, 1908.

*Klopicoris* n. gen.

Aspect of *Camptobrochis* but with the form of *Sixeonotus* nearly. Prosternal xyphus strongly convex, almost tumid, without a marginal carina; pronotum with a conspicuous apical collar; elytral membrane with but one areole; hind tarsi short, basal joint enlarged and strongly oblique at apex, extending beyond the very small and oblique second joint; third joint terete, not at all expanded; tarsal claws large, strongly curved, with the short and broad arolia united with their basal one third.

Head and pronotum almost exactly as in *Camptobrochis nebulosus*. Head nearly vertical, the facial angle a little less than a right angle, viewed from before broad and transverse, the portion before the eyes narrow; vertex immarginate at base, front flat. Eyes elongated, reaching almost to the gula. Clypeus prominent, its depressed base well above the line of the antennæ; gula short, oblique. Antennæ short, inserted a little below the middle of the inner margin of the eyes; basal joint short, scarcely attaining the apex of the clypeus; second about as long as the pronotum, slightly but distinctly clavate at apex; third and fourth together about two-thirds the length of the second; fourth hardly longer than the first; these joints more slender but not setaceous. Pronotum strongly convex in both diameters, steeply declined anteriorly; sides and hind margin strongly arcuated; anterior margin short with a conspicuous convex collar; callosities small, contiguous, placed close to the anterior margin; surface coarsely remotely punctate. Scutellum large, rounded behind, tumidly convex and polished. Elytra broad and short; scarcely longer than the abdomen; a little wider behind; costa narrowly expanded towards the base and feebly sinuated at the middle; surface polished, impunctate, bullate behind, the claval suture with a single row of punctures; cuneus broad, transverse, almost vertical, its apex obtuse, fracture deep. Membrane nearly vertical, uniareolate. Osteolar orifices large, broad-triangular. Rostrum short, reaching the intermediate coxæ. Hind tarsi short; basal joint longer than the two following together and moderately expanded; the second very short, lying within the oblique apex of the first; third short, terete.

This genus is aberrant wherever it may be placed and seems in a way to connect the Capsinæ with the Bryocorinæ.

Type: *Camptobrochis phorodendronæ* Van D.

*Psallus albatus* n. sp.

Aspect of *Plagiognathus spilotus* Fieb. Whitish; clypeus, basal joint of the antennæ, vitta on either side of the pronotum, clavus within, two subapical marks on the corium and two on the membrane piceous or black. Length 4 mm.

Head moderately produced, almost vertical. Vertex nearly as broad as long, convex, polished, without a basal carina. Clypeus prominent, its base a little above the line connecting the base of the antennæ, not separated from the vertex by a distinct impressed line. Eyes minutely granulated, reaching well below the middle of the sides of the head; angle of the face much less than a right angle. Antennæ inserted close to the eyes and a little above their lower angle; basal joint scarcely surpassing the clypeus. Pronotum about as in genus *Plagiognathus,* about one-half broader than long; anterior margin straight, posterior feebly concavely arcuated; callosities large, contiguous. Basal lobe of the scutellum a little exposed. Elytra somewhat longer than the abdomen, subparallel, a little wider behind, the costa very feebly arcuated. Oviduct of female reaching well toward the base of the venter.

Color a soiled white, more or less tinged with fulvous on the vertex, anterior lobe of the pronotum, scutellum, base of the elytra and the femora, especially in the male. Clypeus and basal joint of the antennæ, its extreme apex excepted, black and polished; sides of the pronotum behind the callosities both above and below, inner half of the clavus, and two elongated spots toward the apex of the corium dull black. Membrane white with the areoles and a spot beyond the cuneus fuscous in the female, the male has these marks much extended leaving only the middle area of the membrane pale; veins pale in both sexes. Base of the pronotum discolored by the black mesonotum beneath. Hind femora with a few black points irregularly placed; tibial spines black but without black points at their base; tarsi infuscated. In the male the abdomen is black and

the sternum broadly black; in the female the pleural pieces and ventral and genital segments are bordered with black and the sternum is narrowly black.

Described from numerous examples beaten from sycamore trees at Hamburg and Gowanda, N. Y., in July and August. Mr. Heidemann has sent me the manuscript name of *Plagiognathus albatus* Uhler for this species but the description seems never to have been published. This insect varies much in the extent of the dark markings and in some they coalesce and are so extended as to give the insect a strong resemblance to *Plagiognathus obscurus,* but the long female oviduct, the unspotted tibiæ and irregularly dotted femora will distinguish it from that species and genus.

*Psallus vaccini* n. sp.

Allied to *absinthii* Scott. Smaller and paler than *juniperi* Heid. Oblong; white; minutely white pubescent; irrorate with minute fuscous points which omit the nervures. Length 3½ mm.

Head a little oblique; as seen from before longer and more pointed than in the allied species; viewed from the side produced beyond the eye for about the width of the eye. Clypeus small, distinct, the basal suture obvious but not conspicuous, scarcely attaining the line of the antennæ. Eyes oval, nearly vertical, strongly granulated, reaching well down toward the gula. Antennæ long, basal joint but little surpassing the clypeus; third but little shorter than the second; fourth short and setaceous, little longer than the basal. Pronotum short, scarcely longer than the head; anterior margin feebly sinuated; base and sides straight, the latter strongly oblique. Scutellum small, equilateral. Elytra long, parallel, about two times the length of the abdomen. Hind femora rather broad and flattened.

Color whitish tinged with testaceous on the head, callosities and scutellum; the pronotum, scutellum and elytra dotted with fuscous, these dots fewer on the disk of the elytra anteriorly and on the base of the cuneus, sometimes wanting on the disk of the pronotum where there may be a dusky cloud from the dark mesonotum showing through. Elytral commissure with a brown line beyond the tip of

the clavus. The brown dots are segregated on the apex of the cuneus and to a less extent on the apical one-fourth of the corium. Membrane milky with white veins and four marginal brown marks, the two nearest the apex larger. Antennæ pale testaceous, the basal joint white with a black dot within; second obscurely dotted with brown. Femora with brown irrorations toward their apex which are more conspicuous on the hind pair; tibiæ pointed with black. Beneath more testaceous or a little infuscated.

Described from six male and two female examples. The latter are brachypterous, oval in outline, with the membrane abbreviated, scarcely exceeding the corium and not attaining the apex of the abdomen. When fresh this insect is covered with white scale-like hairs which are soon lost leaving the surface polished. These short females have somewhat the aspect of genus *Chlamydatus* but the produced head at once distinguishes them. I swept these insects from a field of low cranberries near the seashore at Ipswich, Mass., July 22, 1909.

Dr. Poppius has recently established a genus *Pseudatomoscelis* for *Atomoscelis seriatus* Reut. and one new species from Texas. I am, however, unable to find any good characters by which to distinguish this genus from *Psallus* and for the present prefer to unite them. Of genus *Atomoscelis* Reut. I know of but one North American species which was recently described by me from California as *Tuponia modesta.*

Uhler's *Atomoscelis pilosulus* is, I believe a *Psallus.* I have a closely allied form which may be but a color variety. I give below a description of this form.

*Psallus cuneotinctus* n. sp.

Aspect of *diminutus* Kirschb. but smaller. Evidently closely allied to *Atomoscelis pilosulus* Uhler. Whitish, cuneus rosy and sometimes the white upper surface tinged with red. Length 3½ mm.

Head shorter than usual in this genus, abruptly pointed before, nearly vertical; vertex strongly convex in both diameters, polished, its base smooth, without a carina. Clypeus but slightly prominent, its base but poorly distinguished from the front. Viewed from the

side the head is a little longer than in *Atomoscelis* but distinctly shorter than in *Psallus juniperi* and its allies, moderately oblique, the facial angle distinctly less than a right angle. Eyes small, vertical, reaching below the middle of the sides of the head. Antennæ inserted close to the lower angle of the eye; first joint a little surpassing the clypeus. Pronotum short, transverse, its anterior margin sinuated; callosities distinct, coalescing anteriorly. Elytra parallel, the cuneus attaining the tip of the abdomen.

Color whitish, sometimes uniformly and quite strongly tinged with sanguinous above, the cuneus bright red; head and sometimes the pronotum and scutellum more or less fulvo-testaceous, in this case the callosities greenish. Basal joint of the antennæ black with its extreme apex white, remaining joints soiled white; knees with a distinct black point, the hind tibiæ conspicuously dotted with black. Membrane faintly fuliginous with concentrically iridescent zones and marked with a marginal fuscous spot beyond the cuneus and two smaller ones on the tips of the areoles; nervures white.

Described from sixteen examples taken by Prof. J. C. Bradley at Sisson, Calif., in August, 1908. This species is evidently congeneric with *Atomoscelis pilosulus* but Dr. Uhler does not mention the bright rosy cuneus and I am convinced that the present form will at least have a good standing as a variety if, on comparison, it does not prove to be a distinct species. The more pointed face and less obvious incisure at the base of the clypeus as well as the general facies remove this form from *Atomoscelis*. It differs from *Psallus* by the shorter head and more convex and polished vertex but is best placed here for the present.

*Catonia bicinctura* n. sp.

Most nearly related to *picta* but darker in color with the facial bands narrower. Length 5 mm.

Head longer than in our other species. Vertex distinctly longer than in *picta* and narrowed anteriorly; apical margin sub-angularly rounded. Front a little narrower, more contracted at base with the sides a little more arcuated.

Color. Female: fuscous-brown; vertex, pronotum, middle of the anterior margin and apex of the mesonotum paler; middle of the face a shade darker than the base and clypeus, this darker shade bounded by a straight clean-cut whitish band between the antennæ, and a feebly curved one on the base of the clypeus; these bands about one-half the width of those seen in *picta,* the lower band is carried across the propleuræ as a slender oblique white line; marginal carinæ obscurely dotted. Pronotum with about four short longitudinal pale carinæ behind the eyes. Mesonotum immaculate except for the paler apex and anterior margin. Elytra slightly paler toward the costa, nervures obscurely pale, dotted with black, the costal stout, white, maculated with fuscous, apical margin with a series of oblong fuscous spots, that on the stigma larger. Legs testaceous, lined with fuscous, the knees with a whitish point. Abdomen sanguineous or nearly so, becoming paler at apex.

The male is darker in color with the elytral points less conspicuous, the frontal bands fulvous tinged with saffron, the abdomen rufous-brown, and the legs darker with two narrow pale bands on the anterior and intermediate tibiæ, which are but indicated in the female.

Described from three examples taken in Florida by Mr. W. T. Davis; one pair at Punta Gorda, on November 12, 1911, and a female from Newberry taken on November 19, 1911.

*Catonia producta* n. sp.

Allied to *majusculus* Van D. but smaller and with a longer head. Yellowish varied with darker, mesonotum fulvous, front pale, unicolorous. Length 5½ mm.

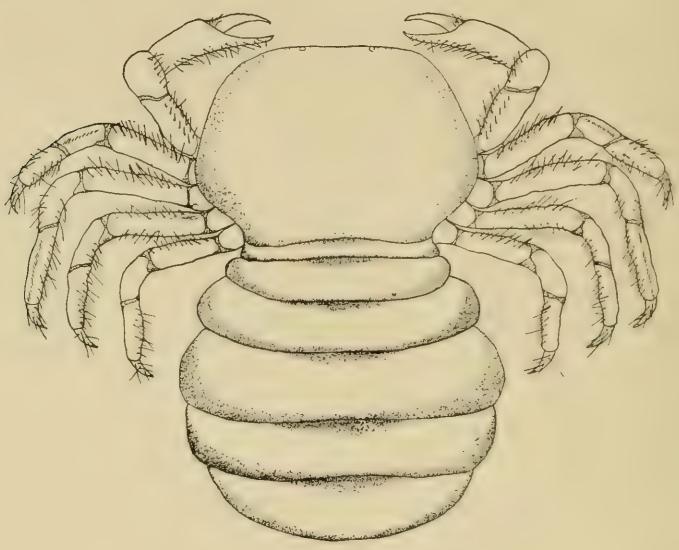
Head small, shaped about as in genus *Elidiptera.* Vertex narrow, horizontal, produced for about one-half its length before the eyes, somewhat narrowed to the rounded apex, the margins carinately elevated as in *Elidiptera;* its base sub-angularly excavated. Front narrow, strongly tri-carinate, much narrowed to the base which is scarcely one-half as wide as the apex. Pronotum a little longer than in *majusculus,* broadly, angularly, but not deeply excavated at base, forming a rounded flap behind the eye as is usual in this genus.

Color pale yellowish-testaceous, more or less tinged with fulvous, the mesonotum deep rufo-fulvous; face paler with the carinæ whitish. Vertex and disk of the mesonotum more or less infuscated. Elytra darker fulvo-testaceous; clavus exterior to the outer nervure and an oblique costal spot reaching at least to the middle of the disk more or less distinctly whitish, the outer claval nervure conspicuously white and the surface enclosed by it of a rich brown; stigma, a series of lines along the apical margin and sometimes the commissural nervure on about its apical one-half blackish; apex of the elytra beyond the stigma smoky subhyaline, the large costal areole beyond the stigma yellowish and followed by a fuscous cloud, the apical and at least two of the subapical transverse nervures thick and white; the nervures mostly strong and conspicuous.

Described from two female examples taken about the base of redwood trees in Muir woods, Marin County, Calif., September 5, 1914. This species agrees with *majusculus* in having a much longer pronotum than is usual in *Catonia,* with the hind margin less deeply excavated. In the form of its head it approaches *Elidiptera* but differs in wanting the longitudinal compartment behind the eyes.

# The Blind Crab Found at Laguna Beach

A number of individuals of the species *Fabia subquadrata* Dana have been found from time to time at Laguna Beach living within the shells of the largest mussels of the species *Mytilus californianus*



Cor., and probably also *M. bifurcatus* Cor. The drawing, enlarged twice, is by Edmund Stone of Pomona College.

*(Contribution from the Zoological Laboratory of Pomona College)*

# Preliminary List of Common Heteroptera From the Claremont-Laguna Region

R. A. LA FOLLETTE

The following is a list of species from some of the common families of Heteroptera found in this region. A short description of colors is given where it will aid in distinguishing the species.

PENTATOMIDÆ

*Euchistus impictiventris* Stal.

Dark brown (Fig. 1), 11½ mm. by 6½ mm. broadest part. Claremont and Mts. near.

*Thyanta perditor* Fab.

9 mm. by 6 mm. Bright green shoulders, sharp pointed. Claremont.

*T. custator* Fab.

11 mm. by 6 mm. Bright green with reddish band from shoulder to shoulder in most cases. (Fig. 2.)

*Banasa dimidiata* Say

9 mm. by 5 mm. Olive brown, head brick red. Mts. near Claremont.

*Prionosoma podopioides* Uhl.

9 mm. by 5 mm. Golden brown, hairs on head, antennæ and about edge of body, caudal half of body serrated. Catalina Island and Mts. near Claremont.

*Cosmopepla conspicillaris* Dal.

7 mm. by 4 mm. (Fig. 3.) Black with red band from shoulder to shoulder. Scutellum tipped with red. Red rim about the body. Claremont and Mts. near.

*Eysarcoris intergressus* Uhl.

5 mm. by 4 mm. Color golden copper. (Fig. 4.) Mts. near Claremont.

*Murgantia histrionica* Hahn

10 mm. by 7 mm. Black with red spots. (Fig. 5.)

*Brochymena quadripustulata* Fab.

(Fig. 6.) Brown. Claremont and Laguna.

*Neottiglossa carifrons* Stal.

6 mm. by 3 mm. Gray touched with black. Claremont. (Fig. 7.)

*N. undata* Say

6 mm. by 3 mm. Gray and black. Claremont.

*Peribilus limbolarius* Stal.

7 mm. by 5 mm. Brown scutellum tipped with yellow. Claremont.

LYGÆIDÆ

*Lygæus melanocoryphus bicrucis* Say

8 mm. by 3 mm. Red with yellow border. Claremont.

*L. turcicus* Say

11 mm. by 4 mm. Red and black with two white spots on the wings. (Fig. 10.) Claremont and Laguna.

*L. protensis* Linn.

6 mm. by 3 mm. Laguna.

*L. sallei* Stal.

5 mm. by 2 mm. Light brown, wings prominent. Laguna.

*Oncopeltus faciotus* Dal.

Orange and black. Claremont.

*Hyoidea grisca* Uhl.

4 mm. by 2 mm. Small. Light dirty green. Claremont.

*Chlrochroa* sp.

Green. Laguna.

COREIDÆ

*Chelinidea vittigera* Uhl.

13 mm. by 5 mm. Golden copper, with gold stripes down center of head. Light yellow veins on the wing bright yellow. (Fig. 12.) Claremont.

*Catorhintha texana* Stal.

12 mm. by 4 mm. Copper brown color. (Fig. 13.) Claremont.

*Marqus inconspicuus* H. S.

Claremont.

*Aufeius impressicollis* Stal.

6 mm. by 2½ mm. Gray with dark spots about edges of wings. (Fig. 14.)

*Harmostes fraterculus* Dist.

7½ mm. by 3 mm. Distinct old gold. Scutellum short and pointed. Claremont.

*H. reflexulus* Say

7 mm. by 2½ mm. Light brown on dorsal side, scutellum and edge of wing yellow. (Fig. 15.) Claremont.

*Niesthrea lateralis* var. *roseus* Baker

5 mm. by 2 mm. Color very light greenish yellow, brownish on wing covers. Prominent eyes. Claremont and Mts. near.

*N. sidæ* var. *scutatus* Stal.

7 mm. by 2½ mm. Old gold color, wings heavily veined. Claremont.

*N. s.* var. *validus* Uhl.

Light golden yellow, hairy, brown spots on fore part of forewings. Margin of body yellow with brown spots. Claremont.

*Corizus scutatus* Stal.

7 mm. by 3 mm. Dark brown faintly spotted with gray. Spots about edge of wing.

*Seventha trivittata* Say

Claremont. (Fig. 16.)

SCUTELLERIDÆ

*Homomeus proteus* Stal.

6 mm. by 4 mm. Light gray brownish spots, head darker. (Fig. 17.) Mts. near Claremont.

*H. grammicus* Wolff

5 mm. by 3 mm. Light brown streaked with darker markings, head darker. (Fig. 18.) Claremont and Mts. near.

*H. bijugis* Uhl.

6 mm. by 4 mm. Light yellow with light brown streaks running the length of the body. Claremont and Mts.

*Eurygaster cavinatus* Van D.

12 mm. by 7 mm. Dull copper with little specks.

*E. alternatus* Say

9 mm. by 5 mm. Copper red shading off in spots to a light yellowish copper. Small dark spots about edge. Claremont and Laguna.

*Sphyrocoris punctellus* Stal.

Claremont.

REDUVIIDÆ

*Apiomerus flaviventris* H. S.

*A. immundus* Champ. 15 mm. by 5 mm. Black, yellow border; spots of red on legs. (Fig. 21.) Claremont and Laguna.

*Zelus socius* Uhl.

Mts. near Claremont.

*Z. incarnatus* Berg.

Claremont.

*Darbonus productus* Uhl.

Brown. Claremont.

*Conorhinus productus* Uhl.

(Fig. 22.) Claremont.

*Rasahus thoracicus* Stal.

19 mm. by 6 mm. Golden yellow with black and yellow wings. From Mts. to coast.

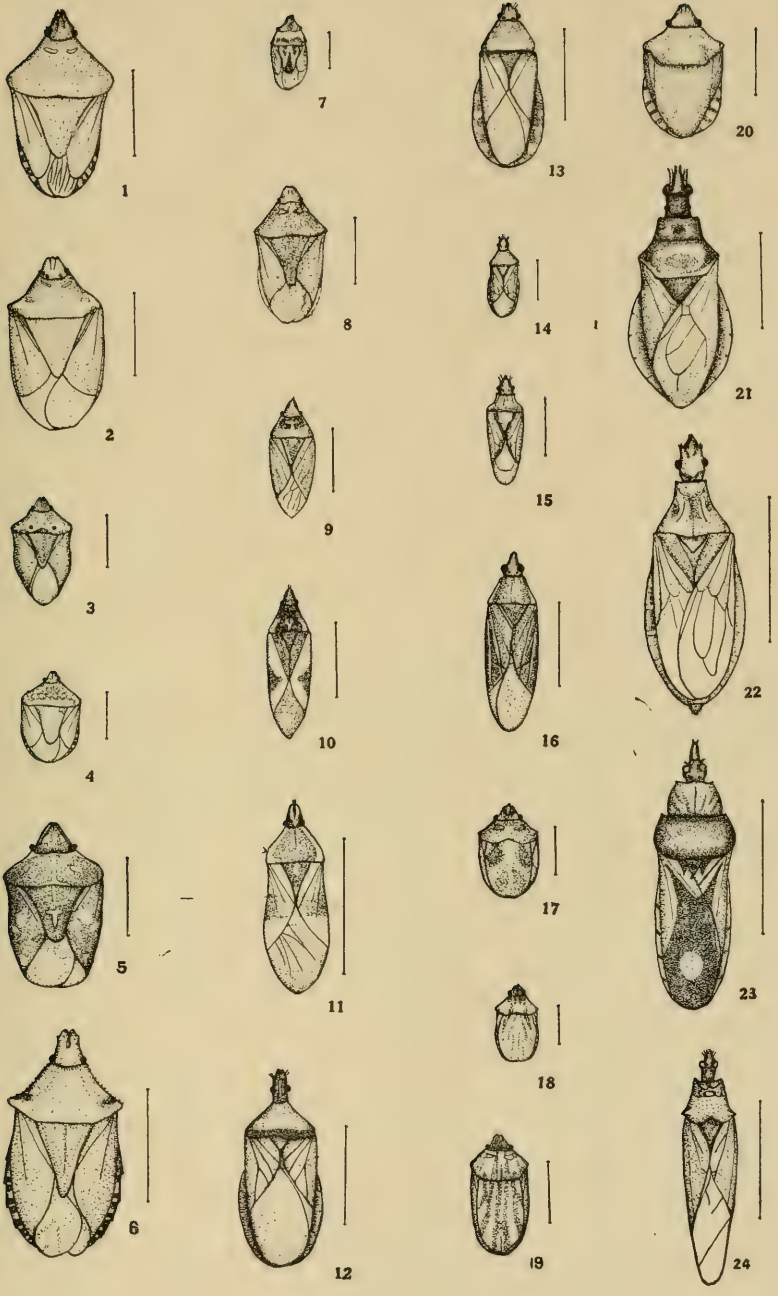
*R. bigultatus* Say

20 mm. by 6 mm.

Claremont and Laguna.

*Rhynocoris ventralis femoralis* V. D.

11 mm. by 3 mm. Body and legs black, wings very light brown. Laguna Beach.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CAPSIDÆ

*Atomoscelis seratus* Bent

2 mm. by 1 mm. Very light green. Claremont and Mts. near.

*Piagiognatharia moerens* Uhl.

5 mm. by 2 mm. Light yellow and black. Claremont.

*Rhinacola forticornis*

3 mm. by 1 mm. Brownish black. Claremont.

*Engytatus simplex* Reut.

1½ mm. by ½ mm. Yellowish white. Claremont and Mts. near.

*Diaphnidia pellicucuida* Uhl.

1 mm. by ½ mm. Wings greenish white, body dirty yellow. Claremont.

*Hyoidea grisea* Reut.

5 mm. by 2 mm. Yellow olive green. Thorax, a few spots of black.

*Dicyphus californicus* Reut.

4½ mm. by 1 mm. Slate blue tinge on wings, body black, wings two prominent brown veins. Mts. near Claremont.

*Hoplomachus consors* Uhl.

4 mm. by 2 mm. Light red, body black, light stripe down thorax and head. Claremont.

*Orthotylus planatus* Uhl.

3 mm. by 1½ mm. Dirty white with greenish tinge. Claremont.

*Poscilocapsus lineatus* Fab.

7 mm. by 3 mm. Spotted black and yellow, red head. Claremont.

*Pæciloscytus elegans* Reut.

4 mm. by 2 mm. Black and yellow, red spot on wing covers. Mts. near Claremont.

*Systratiotas brounneosus* Uhl.

6 mm. by 3 mm. Light brown with brick red scutellum and red edges to wings. Mts. near Claremont.

*Trachycoris socius* Uhl.

Greenish black. Claremont and Mts.

*Irbisia politus* Uhl.

5 mm. by 3 mm. Very dark olive green, legs yellowish brown. Claremont and Mts. near.

*Phytocoris roseus* Uhl.

5½ mm. by 2 mm. Very light red. Claremont.

*P. cunescens* Reut.

4 mm. by 2 mm. Grayish white to dark gray. Claremont.

*P. bakeri* Reut.

5 mm. by 2 mm. Light gray. Claremont and Mts. near.

TINGIDIDÆ

*Teleonemia nigrina* Uhl.

3½ mm. by 1½ mm. Light brown. Claremont.

*Corythuca setosa* Cham.

4 mm. by 3 mm. Brown center. Claremont.

*(Contribution from the Zoological Laboratory of Pomona College)*

# The Action of Simple Reagents on the Ganglia of Arthropods

WILLIAM A. HILTON

The ganglia of centipedes and especially those of isopods (*Porcellio*) were removed, placed in various fluids, sectioned and stained. The ganglia were either taken from the decapitated animals and placed in the various reagents or they were first fixed in boiling water and then placed in the fluids. All the specimens were treated alike after remaining for a time in the first fluid, all were carried through the alcohols, cleared, etc., sectioned, stained in eosin and methylene blue and mounted.

Similar experiments are being carried on in this laboratory with the brains of mammals. Differences in detail between the two investigations may be due in part to differences in penetration. The cells of arthropods are very near the surfaces of the ganglia.

The general effects of some of the reagents used are given.

*Acetic acid* 10% after fixation with hot water. Cells deep blue, fibers pink. Overstained blue in the fibrous part settles in a uniform deep color. There is a fine network of pink strands outside the cells. Some cells are with vesicles or light spots but most are pink like the fibrils about. The nuclei are a deep uniform blue. In some places all cells seem to take a deep blue color.

*Oxalic acid* saturated solution. Used directly upon the fresh ganglia. Fibers uniform, cells blue, nuclei clear, fibrils well preserved.

*Tannic acid,* 10%, for fixation. Brown, even blue stain in parts. Not good results.

*Pyrogallic acid,* 10%. Uniform deep blue, fibrils seen on the surface.

Stronger acids seemed to act too quickly, unless used in dilute solutions. No marked results.

KOH, 10% and stronger, used after fixation with heat. In some a fine reticulum of fibers or fibrils was shown with a pinkish stain; the cells were not evident.

KCN, saturated solution in water. Direct action on fresh tissues, no detail in cells, fibres pink.

*Potassium Permanganate* after fixation with heat, 5% solution. All deep blue, deep colored fibers, cells not evident, coarse reticulum between spaces.

*"Osmic acid,"* 1% after heat fixation, fibres straight, reticulum only at edges. Center of ganglion dense mass of fibers and fibrils. Cells deeply colored.

The same reagent used as a fixer gave the same general appearance, only more distinct, with less reticulum. Massed fibers in places not separated into fibrils.

*Phenol,* about 10% after fixation with hot water. Pink fibrils, blue centers of cells, difference between cells and fibers not marked. Possibly cell membrane is broken down, as the cells seem continuous at all points with surrounding fibrils. There are a few vesicles in the cells. Nuclei are deep blue, slightly granular or vesicular. Direct action of the reagent gives similar results with more detail in the nucleus; often there is a blue spot in the center of the nucleus and an irregular cell body with pink fibrils that resemble a reticulum in places.

*Chloroform,* used after fixation. Strands of fibrils are clearly marked, cells deep blue, pink at the edges of the cells.

*Chloral hydrate,* about 20% aq. sol. after fixation. Cells less blue or pink fibrils. No detail in the cells.

*Nitrate of silver* before and after fixation with hot water. No details in cells; coarse reticulum in places.

*Potash alum,* saturated aq. sol. After fixation fibers and fibrils pink, cells blue centers, pink margins; no details.

*Strychnine* after fixation, saturated solution. Fibril reticulum a dull pink, open net work not clearly marked. Cells uniform blue, nuclei clear. In an older specimen more detailed reticulum, cells all dark. In this there is a reticulum with large and small holes.

*Copper sulfate,* nearly saturated solution. Used as a fixer. Fibrils well fixed, pink; cells also well preserved; light blue nuclei, darker cell body; a line of deep blue surrounds the nuclei in some. Other cells have a blue spot in the center. There is some indication of tigroid substance in the cell body.

*Pepsin,* sat. aq. sol. after fixation. In cells where the fluid has apparently not acted long, vesicular nucleus, cell body deep blue, nucleus uniformly light, outer processes of all pink. Cells in some places a uniform blue, not clearly marked. In another specimen, all parts are a deep blue, no details, fibrils compact but with some indications of a *very fine* reticulum.

Direct action of pepsin, deep blue, cells not evident, but holes remain where they were. No details.

In comparison with the action of reagents given above and by other methods, a study was made of the fresh ganglia taken directly from the animals and studied in normal salt. Intravitam stains were also tried. Details in the cells were not clearly made out by those methods, but some conditions were determined in the fibers and fibrils.

## Points Suggested by the Experiments

1. In many cases the results obtained by the use of the reagents were about the same whether the ganglia were first fixed in boiling water or not.

2. In nearly every experiment when the cells were not completely destroyed the same structures of cell fiber and fibril were evident. The nucleus was usually blue, the cell body blue to pink. Fibrils pink.

3. Vesicles in nucleus and cell body were produced by several of the reagents.

4. The fibrils which make up the mass of the cell and large parts of the nerve trunks as well as central portions of the ganglion are quite resistant to reagents of all kinds. They may be found in practically all of the specimens, although they seem to be differently disposed in various preparations.

The vesicular appearances or more pronounced reticular arrangements are produced by reagents. This is clearly seen when comparison is made with the fresh and probably living ganglion and fibers. The fresh strands in nerves and connectives are straight and parallel, while in certain fixed ganglia the strands are irregular, often massed in such a way as to cling at one place and hang free at another, forming a reticulum, as strands of hair or rope would when wet and partly separated here and there. Of all the single reagents tried osmic acid, both before and after boiling in hot water, gave the least distorted picture of fibers and fibrils.

5. Tigroid substance was seldom seen in a typical distribution, although blue staining material might be concentrated in one or another part of the cell body.

*(Contribution from the Zoological Laboratory of Pomona College)*

# Neuroptera in the Claremont-Laguna Region

## Preliminary List

It is our purpose to publish from time to time lists of animals found in this region. Some will be more or less definite studies in special groups or special distributions. Unless otherwise stated, these lists will be based upon specimens in actual possession of the department. The work of many will be included. Not only the contributions of present and future, but also the extensive collections contributed to the department by Professor Cook and Professor Baker, through a number of years, as well as specimens obtained by Crawford, Metz, Essig and many other special students, as well as material from both Claremont and Laguna Beach which is brought in every year by general classes. For the determination of much of this material we have to thank specialists in all groups all over the country, as well as museums and other institutions.

The purpose of these lists is in part as follows:

(1) To learn what animals occur in this region, for the purpose of later studies both by the college and others.

(2) To let others know what we have.

(3) To have the benefit of criticisms and suggestions concerning the species in these preliminary lists, so that we may be able to detect errors and make new collections in special groups where it seems especially needful.

In no sense are these lists final, and they are necessarily more or less incomplete and far from exhaustive in many cases.

W. A. Hilton.

## NEUROPTERA

Raphidiidæ.

*Raphidia occulta* Bks. Length 12 mm. This species is fairly common about Claremont. Students bring in specimens every year.

*R. californica* Bks. Length 26 mm. This is not so often found.

CHRYSOPIDÆ.

*Chrysopa californica* Coq. This common species is found near Claremont and in the mountains.

*C. rufilabis* Bks. Our only specimen is somewhat smaller than the last.

*C. furculata* Bks.

*Eremochrysa californica* Bks. From the mountains north of Claremont. This has darker wings.

HEMEROBIIDÆ.

*Polystoechotes punctatus* Fabr. Length 30 mm., depth 10 mm. A large, broad-winged species. Many irregular large dark spots on the fore wings.

*Micromus variolosus* Hay. Length 8 mm.

*Sympherobius angustus.* Length 6 mm.

*S. perparvus* McL. Length 5 mm. Our smallest species.

*S. californicus* Bks. Length 6 mm. Found at Laguna Beach.

*Hemerobius pacificus* Bks. Length 10 mm. These have been found at Claremont and Laguna Beach.

*Megalomus latus* Bks. Length 9 mm. The fore wings marked by a triangular dark patch near the center of the wing. There are other dark marks on the wings.

MYRMELEONIDÆ.

*Brachynemurus longipalpus* (?) Hag.

*B. sackeni* Hag. Abdomen marked above by light spots widely separated. From the mountains to Laguna Beach.

*B. Papago* Cur. Thoracic region speckled with dark and light areas. Abdomen with *small* light spots. From Claremont and Laguna.

*Myrmeleon distans* Bks. Clear wings, rather dark body. From Laguna Beach.

*(Contribution from the Zoological Laboratory of Pomona College)*

# Chrysomelidæ (Coeoptera) in the Claremont-Laguna Region
## (Preliminary List)

RALPH P. JAMES

*Haltica carinata* Germ. Small, 4 mm. by 2 mm. Purplish-copper colored. Claremont.

*Crepidodera cucumeris* Horn. 2 mm. by 1 mm. Grayish brown. Claremont.

*Systena tæniata* Say. 3.5 mm. by 1.5 mm. Grayish yellow. Narrow brown stripe down center of elytrum and broader stripe along inner margin.

*Glyptina cerina* Lec. 2 mm. by 1 mm. Reddish-yellow. Pomona.

*G. atriventris* Horn. Slightly smaller than the above, deeper shade.

*Phyllotreta lewisii* Cr. 2 mm. by 1 mm. Shining black. Mountains near Claremont.

*Odontota californica* Horn. 4 mm. by 1.5 mm. Rather square cornered body, light brown, fine ridges running longitudinally on elytra, head and prothorax small. Mountains near Claremont.

*Cassida texana* Cr. 5 mm. by 3.5 mm. Oval, dull green, fine irregular gray or black markings; fine ridges on elytra; flattened at margin all about. Claremont and mountains.

*Psylliodes punctulata* Mels. 3 mm. by 1 mm. Shining coppery black. Laguna Beach.

*Longitarsus livens* Lec. 2.1 mm. by 1 mm. Grayish brown; rather egg-shaped. Laguna Beach.

*Luperodes torquatus* Lec. 4 mm. by 1.3 mm. Prothorax red, elytra emerald green. Mountains near Claremont.

*Gastroidea cæsia* Rog. 5 mm. by 2 mm. Purplish green. Claremont.

*Diabrotica soror* Lec. 6 mm. by 4 mm. Pear shaped; greenish-yellow elytra with twelve irregular black dots. Claremont.

*D. trivittata* Mann. 5.5 mm. by 2.2 mm. Elongate yellowish gray elytra with dark brown stripe down middle and along each inner edge; reddish-yellow thorax, black head. Laguna Beach.

*Trishabda flavolimbata* Mann. 9 mm. by 3½ mm. Rather pear-shaped. Bluish-green elytra with gray border on outer edge. Laguna Beach.

*Monoxia* sp. 3 mm. by 1.5 mm. Grayish brown. Claremont.

*Loma trivittata* var (?). 7 mm. by 3.5 mm. Shining brown with black stripes down middle of each elytron and along inner edge.

*Coscinoptera æneipennis* Lec. 6 mm. by 3 mm. Thick prothorax gray, with coppery elytra dark. Mountains near Claremont.

*Saxinis saucia* Lec. 5 mm. by 3 mm. Grayish blue body, metallic blue prothorax and elytra, red spot on shoulder of each elytra. Claremont and mountains near.

*Exema conspersa* Mann. 2 mm. by 1.2 mm. Rough, brownish-black, almost cylindrical. Claremont.

*Cryptocephalus sanguinidollis* Saffr. 4 mm. by 2.5 mm. Shining black elytra and head, prothorax black. Claremont and mountains near.

*C. spurcus* Lec. 4.5 mm. by 3 mm. Brownish yellow with three narrow darker brown stripes down each elytron. Claremont and mountains near.

*Pachybrachys punctatus* Bowd. 4 mm. by 2 mm. Yellowish brown elytra, square head. Laguna Beach.

*Glyptoscelis squamulatus* Cr. 8 mm. by 4 mm. Gray, faint lighter straps down elytra. Slight silvery appearance. Laguna Beach and Claremont.

*Chrysochus cobaltinus* Lec. 10 mm. by 6 mm. Brilliant metallic purplish blue. Claremont.

*Colaspidea varicolor* Cr. 3½ mm. by 2 mm. Coppery metallic luster. Claremont.

*(Contribution from the Zoological Laboratory of Pomona College)*

# Amphibia of the Claremont-Laguna Region
## (Preliminary List)

Three species of Urodela have been found in this region.

*Batrachoseps attenuatus* Esch. This very slender species has been found more widely distributed than any other in this region. It is most easily found during wet years. Individuals have been collected during the past two years from well up in the mountains in Cow canyon, one of the branches of the San Gabriel. They have been found abundantly in and about Claremont. Some were collected on top of the highest hills near Laguna, as well as in one of the smaller canyons less than a mile from the sea. A number of specimens were also obtained from Catalina Island.

*Autodax lugubris* Hallow. So far this species, or animals resembling it, have been obtained from the mountains. It has not been found abundantly. Only some of the lower canyons which are rather rocky have furnished specimens, such as Stoddard's and Cucamonga.

*Diemyctylus torosus* Esch. This large aquatic salamander is found in many of the larger canyons and in water which flows from mountain streams. We have found it most abundantly in San Dimas, Cucamonga, Live Oak, Big Dalton and Palmer's. It probably occurs in many others.

We have but five species of Anura so far:

*Bufo halophilus* Baird. Common in all the region from the mountains to the sea.

*Hyla arenicolor* Cope. Gray or brown spotted or blotched or unspotted. Found in the canyons.

*Hyla regalla* Baird and Girard. These little frogs, gray, brown, green or red are probably found in all the region. They have been found breeding this year in February among the hills near Pomona. They were found very abundantly among the tall vegetation about the lakes near Laguna Beach.

*Rana pretriosa* Baird and Girard. This frog is found in most of the larger streams in the mountains.

*Rana draytonii* Baird and Girard. One specimen of this large frog was brought in from San Dimas canyon in 1914.

*(Contribution from the Zoological Laboratory of Pomona College)*

# Elateridæ (Coleoptera) From the Claremont-Laguna Region

## (Preliminary List)

RAY E. GARDNER

*Plastocerus schaumii* Lec. Length 13 mm., width 3.5 mm. Light yellowish brown. Prothorax quite narrow. Claremont.

*P. schaumii* Lec. Variety. Length 14.5 mm. Somewhat darker brown. Claremont.

*Aplastus speratus* Lec. Length 14 mm., width 3 mm. Elongate sub-convex. Antennæ long. Dark brown, but rows of yellowish hairs give it a lighter appearance.

*Aphricus californicus* Lec. Length 6.5 mm., width 1½ mm. Black, roughly punctate antennæ very long and moderately serrated. Body elongate, showing suture on back; mandibles long and slender. Claremont.

*Euthysonius lautus* Lec. Length 24 mm., width 6 mm. From a red to a dark brown. Elongate, subconvex. Prothorax pointed on each side behind. Antennæ pectinate. Claremont.

*Cardiophorus tenebrasus* Lec. Length 8.6 mm., width 2.5 mm. Body elongate, subconvex, prothorax very convex, body black, legs reddish. Antennæ serrate. Slight covering of greenish hairs. Claremont and mountains near.

*C. ænus* Horn. Length 4 mm., width 1.5 mm. Thorax rounded, shiny. Dark reddish brown elytra slightly lighter than thorax, slightly covered with hair. Antennæ longer than thorax. Claremont.

*C. crinitus* (?) Blanch. Very much like *C. tenebrasus,* only smaller. Length 6.5 mm., width 2 mm. Prothorax broad.

*Ludius lecontei* Horn. Length 25 mm., width 6 mm. Elongate, moderately robust, gradually narrower and tapering behind the middle. Black.

*Elater cordatus* Horn. Length 11 mm., width 3½ mm. Wedge-shaped, elongate, subconvex. Elytra orange or light yellowish

brown, each with large black spot near the tip. Claremont and mountains near.

*Elater cordifer* Lec. 9 mm. by 3 mm. Much like the last mentioned. Mountains near Claremont.

*Megapenthes tartareus* Lec. 10 mm. by 3 mm. Dull black, antennæ long and strongly serrated.

*Dolopius lateralis* Esch. 9 mm. by 2 mm. Light brown on the dorsum; body very narrow; antennæ moniliform, nearly serrated. Body yellow on ventral side. Claremont and mountains near.

*Melanotus longulus* Lec. 9 mm. by 2½ mm. Body black on both sides, covered with many white hairs. Antennæ slightly serrated. Claremont and mountains.

*Limonis vernalis* Fall. 8 mm. by 2 mm. Elytra reddish brown, shining. Mountains near Claremont.

Another lot of the same genus were larger.

*L. californicus* Man. 9 mm. by 2½ mm. Dull brown. Claremont.

*Athous excavatus* Mots. 10 mm. by 3 mm. Dark brown, elytra with marked ridges, prothorax bright reddish, brown stripe either side of the head. Claremont.

*Serocosomus debilis* Lec. Length 5 mm. by 1½ mm. Light brown, head darker.

*(Contribution from the Zoological Laboratory of Pomona College)*

# The Biology of the North American Crane Flies (*Tipulidæ Diptera*)

CHARLES PAUL ALEXANDER,
ITHACA, N. Y.*

## IV. *The Tribe Hexatomini.*

The tribe Hexatomini includes the four genera, *Hexatoma, Cladolipes, Eriocera* and *Penthoptera,* representatives being found in all portions of the temperate and torrid zones with the exception of the Australasian region. The Nearctic genera will be considered in the order given above.

### Hexatoma Latreille.

This genus includes a small number of forms with a Holarctic distribution, there being thirteen European and one North American species as yet described. Our fragmentary knowledge of the life-histories of members of this genus was indicated in a paper by Mr. Lloyd and the author. (The genus *Eriocera* Macquart, 1914 Journal of Entomology and Zoology, vol. VI, 12.)

Hexatoma megacera Osten Sacken.

*Hexatoma megacera* Osten Sacken; Proc. Acad. Nat. Sci. Phila., 242, 1859.

This is the only Nearctic species as yet discovered. It is found throughout northeastern America, the distribution of the insect so far as known being as follows:

*New York,* Fulton Co., Sacandaga River, June 6-18, 1909; Johnstown, May 24, 1909 (Alexander); Tompkins Co., Ithaca, May 3-15, 1912 (Alexander). *Connecticut,* Litchfield Co., Chapinville, May 26, 1904 (Britton). *Maryland,* Osten Sacken's type; Montgomery Co., Cabin John Bridge, April 28, 1912 (Malloch). *District of Columbia,* Washington, early spring, Osten Sacken's type. *Virginia,* Fairfax Co., Glencarlyn, May 1, 1910 (Knab).

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*Contribution from the Limnological Laboratory of the Department of Entomology in Cornell University.

The life-history of this very interesting species is still not well known. The larva lives in gravel or sand along the banks of streams. On April 26, 1914, some gravel from the banks of Cascadilla Creek, Ithaca, N. Y., was examined near the place where the pupal skins were found in 1913 (see later). No signs of larvæ or pupæ were discovered after a close search. On May 6, the same bank was examined and some ten larvæ and seventy-five pupæ were found. They occurred in the gravel that was thickly penetrated by grass-roots and rhizomes; pure gravel was nearly destitute of these insects. Associates of these larvæ and pupæ at this time were *Paederus littorarius, Laccobius agilis,* many larvæ and pupæ of *Tabanidae* and a few *Eriopterine* crane-fly larvæ. Some of the larvæ pupated during the night while in water contained in a flat porcelain dish. The above data seems to indicate that the larval existence is spent in or under the water of the stream and the larva comes to live in the sand along the edge of the stream only when fully grown and ready to pupate.

The pupa occurs in the sand as described above, usually in company with the larvæ of the species and various associates. The following data is taken from my field notes, May 2, 1913: Two fully grown pupæ and several cast pupal skins were found on a pebbly beach along Cascadilla Creek. They were much rarer than the adult flies of two years ago and the number of cast skins per square foot for any place was only three or four, nothing like the numbers found in the related *Eriocera longicornis* Walker. May 3, 1913. One pupa found on a pebbly beach along the Inlet (Ithaca) by J. C. Faure. It was in the loose sand with such natural associates as the following: larvæ and pupæ of the deer-fly, *Chrysops excitans,* and many adult beetles, *Cicindela sexguttata,* and *C. vulgaris,* common; *Elaphrus ruscarius,* a few; *Tachys,* sp., several; *Omophron,* sp., *Dyschirius sphaericollis, Agonoderus partiarius, Anisodactylus discoideus, Cryptobium bicolor, Paederus littorarius, Bledius,* sp., etc. The pupa of *Hexatoma* occurred in the same stratum as the adults of *Omophron.*

The adult insects fly during May and June and may be swept from rich vegetation near the streams from which their larvæ emerged.

The following notes on the copulation, resting positions, egg-laying in nature and captivity, and other details may be quoted from field observations.

May 14, 1911—This usually rare insect was common on a grassy plot of land along Cascadilla Creek. The flies sit on the blades of grass, the long antennæ of the male directed straight ahead. The males are very poor fliers and prefer to drop to the ground when disturbed and clumsily work their way off along the ground. When approached from the side they are much more easily alarmed and fly away. When approached from above, they do not move until the stick, finger, or whatnot, is within a couple of inches, when they remove the fore feet from the support and, on nearer approach, fall to the ground. When in copulation, the female tries to disengage by rapidly vibrating the wings in attempted flight, repeating this often, from every 1 to 5 seconds until disengaged or exhausted. The male can disconnect himself at will. In copulation the female is always uppermost unless exhausted, when both sexes lie flat on a grass-blade. The female has the head up, the male the head downward; copulation always takes places on a vertical support, usually a blade of grass, sometimes a plant stem. The sexes remain in copulation for quite a long time and are perfectly motionless. All of the legs of both sexes are on the support unless in a position where this is physically impossible, in which case as many as possible are used; the hind legs of both sexes are held at right angles to the support, the forelegs in front. After copulation the female generally drops to the ground, the male, after a few moments' rest, flies away. Specimens in copulation were found in abundance from 2 to 4:30 p.m. when no more could be discovered. From 4:30 to 7 p. m. solitary males were common, but no females could be found on the grass-blades. At 4:30 p. m., a few females were found clinging to the trunks of the willow trees about two feet from the ground. At 5:30 p. m., females were noted in small groups over the water, evidently engaged in oviposition, as they frequently dipped down to the surface. These latter were in company with a large swarm of dancing Empidid flies *(Rhamphomyia)*. Of the great numbers that were picked from grasses in the afternoon a considerable proportion were fe-

males and toward 5 p. m. they commenced egg-laying on the sides of the containing vessel, large shell vials. By 7 p. m. the sides of the vials were black in places with the large, dark-colored eggs. This data would seem to place the time for oviposition at about sunset. The females are very good fliers and often travel for long distances before alighting as is shown toward sunset when they fly for long stretches up-stream. The males are rather poor fliers, due in part, possibly, to the weight of the long antennæ and, as stated before, this sex prefers to skulk rather than fly. When the males fly, they do so heavily and seize the first support that they collide with and hang on, occasionally flying on immediately to another support. When the male comes in contact with a stem, he very often ascends to the top by means of a part-flying, part-climbing motion and, on reaching the summit, flies off to another place. As a rule the flies, especially the females, alight on a single grassblade, but very often the males are observed on two blades, the legs of one side on one blade and those of the opposite side on the other; when the body thus hangs between the stalks, the tarsi diverge from one another, whereas on a single support, the legs converge.

*Hexatoma* was preyed upon by large numbers of a Scatophagid fly that occurred in great abundance in this vicinity and seemed to be subsisting almost entirely on these flies. At least twenty of these predaceous flies were noted with *Hexatomæ* and this species seemed to constitute the principle insect enemy of the crane-fly. They would lurk on the grass-blades and sally forth after their prey, carrying it back to some point to feed upon it. It is probable that the blood is taken since the body of the *Hexatoma* appeared almost uninjured when examined. On an old beam where males had a habit of walking up the vertical face, a small spider's web was found, in which 11 specimens were entangled, 2 being still alive; 8 of these were males, the remaining 3, females.

The males especially can walk up smooth surfaces, as glass, moving the legs alternately and awkwardly. The first pair taken were in copulation but in placing them in the vial they became disengaged and ran about in the container. After a short time they began to copulate in the tube.

May 15, 1911—A pair were taken in copulation at 10 a. m.; at 8 p. m. they were still in coitu, but this is exceptional as most of the pairs disengage very readily. In the morning the species is very active and although the males do not fly far, they fly readily and it is difficult to pick them up by hand. The females are excellent fliers especially in the morning.

Several pairs were taken in copulation and each pair was isolated in a separate vial in order to ascertain the number of eggs per female. The clutch was determined by dissection. When the captive insects began to oviposit, the eggs shot out from the body, at first slowly, then more rapidly, one per second, later much slower again, the eggs being extruded one at a time. The total period of oviposition required seven minutes; at the end of 60 seconds, in the space between 60 and 70 seconds, 18 eggs were laid, or 1.8 per second. Toward the end of egg-laying, the eggs appeared much more slowly, one in two seconds. The eggs are quite sticky or viscid and adhere to the glass. When the female is in danger of death, as when she falls into the water, she begins, at once, to deposit the egg-complement. In nature it seems probable that one egg is laid at each descent to the water. As soon as the female touches the water, although she has not deposited an egg all day, she immediately starts to deposit the oblong black eggs. After the last egg is expelled the muscles of the ovipositor still go through the motions of expulsion. One specimen was placed in the water and as usual began to deposit her eggs. She was decapitated, laid 11 eggs and tried to lay still more but failed. The number of eggs laid varied from 316 to 372 with an average of 347; the time required for oviposition varied from 7 minutes to 7 minutes and 40 seconds. In most cases the number of the egg-complement is probably between 300 and 400.

## DESCRIPTION OF THE IMMATURE STAGES

### Larva

Length: Fully extended, 14-15 mm.; diameter, 1-1.3 mm.

Body of the larva with rather abundant appressed hairs; the subcaudal enlargement with transverse rows of very small hairs, there being from 35 to 40 such rows.

The head-capsule has the usual Hexatomine shape as described for the genus *Eriocera* by Alexander and Lloyd; labrum oval with a strong, rather chitinized frame; on the cephalic margin produced into a small median lobe bearing two small tubercles (Plate I, Fig. 5); the lateral margins are produced into prominent lobes which are directed inward and cephalad, entirely protecting the front of the labrum and almost meeting one another on the middle line; these lobes densely hairy. Antennæ cylindrical, bearing two or three small hairs and one much longer hair (Plate I, Fig. 3). Mandibles long, slender, acutely pointed as in the members of this tribe, with a very large tooth on the inside near the middle of its length, this latter with a smaller tooth at its base, the inner margin basad of these two teeth is roughened with two or three tiny denticles (Plate I, Fig. 1).

Stigmal field with four lobes of which one pair are lateral and directed caudad and slightly laterad, the round stigmata at the base; the outer face of these lobes is provided with numerous long hairs, these being longest at the tip, shorter at the base. The ventral lobes are longer, directed caudad, the tip provided with a few long hairs and some shorter ones which are continued up the ventral face. The dark markings on the stigmal disk are few, a broad brown suffusion extending from the stigmata dorsad; a narrow brown line along the inner face of the lateral lobes, this mark narrowest at the tip, scarcely enlarged at the opposite end; the ventral lobe has a long slender brown mark extending from the tip cephalad, at the proximal end expanded (Plate I, Fig. 7).

Described from numerous larvæ taken at Ithaca, N. Y., May 6, 1914.

## Pupa

The pupa is quite similar to that of *Eriocera longicornis* differing only in its small size, greater development of the scapal spine, lack of the projection on the mesonotal praescutum, etc. The cephalic crest when viewed from beneath is very different in shape; the fore pair of legs are much shorter than the others, ending just beyond the caudal margin of the second abdominal segment; the hind pair extend far beyond the others, ending beyond the middle

of the third abdominal segment; in some specimens the tarsal segments are much nearer to the posterior margin of the third abdominal segment, but there is always a marked difference in the tips of the tarsi of the various legs.

Male. Cephalic crest viewed from the side, triangular, ending in an acute point which is directed strongly forward (Plate II, Fig. 1). Viewed from beneath (Plate II, Fig. 2), the lobes are conspicuously triangular, pointed, lying parallel or slightly divergent and separated by a deep median split. Spine on the scape of the antennæ very large, conspicuous; tubercle on the labrum strongly developed. Pronotal breathing-horns short, straight. Mesonotum strongly crenulated along the middle line; scutellar lobe not developed. Posterior leg sheaths extending beyond the level of the middle legs, which, in turn, are longer than those of the fore legs. Wing pads dark, the venation not showing clearly, but if made out the very short cell $R^2$ and the reduced $M$ are characteristic of *Hexatoma* alone. Abdomen with about 34 spicules on sternite 4; about 30 in a straight uninterrupted row on tergites 3 and 4; about 20 on tergite 5. Hypopygium with the sternal lobes strongly rounded, enlarged and bent strongly dorsad.

Length: From crest to tip of the abdomen, 9.2-9.6 mm.

Dextro-sinistral width at wing-pad: 1.2 mm.

Dorso-ventral depth at wing-pad: 1.4 mm.

Female. As in the male, the ovipositor viewed from the side with an obtuse notch. From beneath, the sternite is obtusely pointed with a deep median split. From above, the tergite is almost flat across the caudal margin, the lateral angles rounded, a deep median split. The antennal sheaths are much shorter than in the male (Plate II, Fig. 3).

Both sexes of the pupæ described from numerous specimens from Cascadilla Creek, Ithaca, N. Y., May 2, 1913; May 6, 1914.

The larva of *Hexatoma* in many respects is close to *Eriocera fultonensis* Alexander in the shape of the markings on the stigmal disk, the teeth on the mandible and the lateral lobes of the labrum. The pupa, on the contrary, suggests *Eriocera longicornis* Walker very closely in the shape of the cephalic crest, appearance of the

caudal end, etc. These differences are pointed out in the following key:

LARVÆ

1. Size smaller (fully grown, length, 14-15 mm.); mandible with the largest of the two teeth at mid-length, slender, rather sharply pointed; labrum with the lateral lobes produced cephalad and proximad, almost touching one another on the middle line; stigmal field with the dark markings pale, brown, those of the ventral lobes not enclosing an oval pale area at their proximal ends. *Hexatoma megacera* O. S.

   Size larger (fully grown, length, 18-26 mm.); mandible with the largest of the two teeth at mid-length stout, blunt; labrum with the lateral lobes produced cephalad and scarcely proximad, widely separated from one another; stigmal field with the dark markings black or very dark brown, those of the ventral lobes contiguous at their inner ends and there enclosing an oval pale area. *Eriocera fultonensis* Alex.

PUPÆ

1. Size small (length under 10 mm.); scapal spine larger; no projection on the mesonotal praescutum.

   *Hexatoma megacera* O. S.

   Size larger (length over 12 mm.); scapal spine small; a small projection on the mesonotal praescutum.

   *Eriocera longicornis* Walk.

## ERIOCERA Macquart

The information that was available concerning the species of this genus was included in a paper by Alexander and Lloyd cited before (Journal of Entomology and Zoology, VI, March, 1914), but since that article was written a few more items concerning the biology of members of this genus have been ascertained.

ERIOCERA BRACHYCERA Osten Sacken.

*Eriocera brachycera* Osten Sacken; Bull. U. S. Geol. Surv., III, 205, 1877.

This species is one of the rarer forms in the Eastern United States. A pair that was collected by the author on August 4, 1914,

as given below, were observed flying rapidly over the creek-bed of a mountain stream in the dense shade of the forest. The known distribution of the insect so far as known is as follows: *New Hampshire,* White Mts., Osten Sacken's type; Bretton Woods, June 27, 1913 (Johnson). *Massachusetts,* Hampden Co., Chester, Aug. 7, 1912 (Johnson). *New York,* Erie Co., South Wales, July 9, 1911 (Van Duzee); Herkimer Co., Old Forge, July 12 to 16, 1905 (Needham); Fulton Co., Pinnacle Mt., alt. 2000 feet, Aug. 4, 1914 (Alexander). *New Jersey,* Warren Co., Delaware Water Gap, July 4, 1898 (Johnson).

ERIOCERA SPINOSA Osten Sacken.

*Arrhenica spinosa* Osten Sacken; Proc. Acad. Nat. Sci. Phila., 244, 1859.

Messrs. Rich and Ellis, while collecting *Corydalis* larvæ in Fall Creek, Ithaca, N. Y., on Oct. 31, 1914, report the finding in immense numbers of large, almost fully-grown larvæ of this species. They formed a high percentage of all the insect life noted in the rapid water. The observations made earlier by Alexander and Lloyd concerning the carnivorous habits of these larvæ were confirmed by Mr. Rich who placed the larvæ in dishes together with nymphs of various Odonata, the smaller ones of which were eaten by the *Eriocera* larvæ.

ERIOCERA LONGICORNIS Walker.

*Anisomera longicornis* Walker; List Dipt. Prit. Mus.; 1, 82, 1848.

This well-known species was discussed in some detail in the paper on *Eriocera* cited before. Many specimens of larvæ and pupæ have been taken and it seems probable that the larva described in that paper is not typical of *longicornis.* It is preferred to await more data before saying anything further about the insect. The distribution as indicated by my sheets is quite extensive being as follows: *Canada,* Ontario, Nagagami R., June 20-21, 1903 (W. L. Wilson); Little Current R., July 8, 1903 (Wilson). *Maine,* reported by Johnson. *Massachusetts,* collected by Packard. *New Hampshire,* Bretton Woods, June 24-25, 1913 (Johnson). *Connecticut,* New Haven

Co., Oxford, May 21, 1904 (Britton). *New York,* Herkimer Co., Trenton Falls, collected by Osten Sacken; Dolgeville, May 16, 1914 (Alexander); Fulton Co., Northampton, May 28, 1914 (Alexander); Tompkins Co., Ithaca, May 1-10, 1913, (Alexander and Lloyd). *Pennsylvania,* Wyoming Co., North Mt., June 7, 1898 (Johnson). *Maryland,* Plummer's Is., April 12, 1908 (Barber); April 21, 1907 (McAtee); Jackson's Is., May 22, 1913 (Shannon and Barber); Cabin John Bridge, May 16, 1909 (Knab). *Virginia,* Fairfax Co., May (Banks). *Illinois,* collected by Kennicott.

The following supplementary notes on the swarming and mating were made at Northampton (Fish-house) on the Sacandaga River, Fulton Co., N. Y., at the boom of the International Paper Mills.

May 27, 1914—This afternoon across the river from our camp this species was exceedingly abundant. They were there in untold myriads and at every step arose in clouds from under foot or from the leaves of choke-cherry on which they rested. They sat on the leaves with the head directed away from the observer ready to take instant flight. A few were in copulation on the leaves, but from observations made it seems probable that mating begins in the air and the pair seek a support later. Toward twilight this insect may be found in great numbers in company with many kinds of caddice-flies and a few may-flies. Seven p. m.—*Eriocera* swarming in great numbers, from 50 to 200 in a swarm facing the gentle westerly breeze (downstream). One big swarm near the shore numbered at least 2000 individuals and covered a vertical height of at least 50 feet, the base of the swarm being about 15 feet above the surface of the water. Coming back across the boom it was found that several of these great swarms had fused so that one almost continuous swarm of thousands of individuals was formed, extending from shore to shore of the river. A great number of specimens were secured by a few sweeps of the net. When danger approaches, the swarm either mounts into the air overhead or else retreats before the breeze, never going sideways or advancing. Out over the land in the small swarms, copulation was observed several times. The males in the swarm dart rapidly at the females and seize them al-

most instantly. Then they usually leave the swarm and go sailing away, the male above doing the flying, the smaller female hanging limply underneath. After a rather short time they break away and the separated individuals depart. When copulation is prolonged, the male becomes tired and the pair rest on the upper surface of the leaves as described *ante*.

May 28, 1914, 7:15 p. m.—Today at this hour, *Eriocera* is swarming in immense numbers out over the river. Copulation was observed many times. The male grasps the female in the swarm and they fly away, the male above doing all the active work of flight, the female below, entirely passive. The antennæ of the male are directed straight ahead and slightly divergent; the legs hang downward; the wings vibrate rapidly. The female hangs downward with the legs hanging limply; the wings nearly horizontal and motionless. The dead weight of the female keeps pulling the male down toward the water and often both fall into the river. As a rule copulation ends before the male is exhausted. The male opens his forceps and the female drops straight downward for a foot or so exactly like a parachute released from a balloon. If the pair are near the water at the time of separation the released female drops into the water, the male flying away. The released male darts upward again and back into the swarm. The female slowly flies away, usually upstream, sometimes downstream, presumably to lay her eggs; she does not stop for swarms that she may encounter but if she meets these swarms she will make a wide detour in order to avoid them. Often a second male will seize a female already in copulation and the three will come tumbling down into the water together.

In a very few cases the female is the active partner and succeeds in pulling the male where she wills although much smaller. In other cases the female before being released from the male flutters the wings violently as though impatient. Copulation occurred commonly this evening and it is probable that the hours of twilight are the usual ones though several were found mating on leaf-surfaces during the afternoon as mentioned earlier. It may be that these matings started in the air and upon the approach of exhaustion the

male retired to a support although the species was never observed to swarm during the hours of sunlight.

The number of individuals participating in these swarms was again very astonishing, many of the swarms numbering thousands of individuals. The motions in the swarms were very rapid, almost like bees, and the sound produced was a very low pitch, much lower than that of *Culex*.

May 29, 1914—A rather strong southerly breeze blowing. At 6:35 p. m. small swarms of from 25 to 30 individuals had gathered. At this time the sun was still up but low in the west. These swarms were enlarged rapidly. At 6:45 one big swarm was formed near the east bank, this being nearest the point where the insects spend their days and so they swarmed there first. One pairing of three individuals came down as described above and when about a foot above a board in the water, the male in copulation dropped the other two. These rested for a moment and then the male attempted to engage the female in copulation. She resisted but finally he managed to seize her with his forceps. Then he attempted to fly away but she seized hold of the board with all her feet and he was unable to fly away. This seems to prove that the normal place for copulation is in the air.

Enemies: Dragon-flies, *Helocordulia uhleri* Selys, feed upon the *Eriocera* swarms during sunlight. They do their capturing by darting back and forth through the masses of individuals.

Oviposition: Many *Erioceræ* were noted engaged in dipping down to the water as though engaged in the laying of eggs. Only a few individuals allowed themselves to be taken and all of those secured proved to be males. Why males should go through these actions is uncertain to me, but I have observed it many times in several different species. I think that the female lays her eggs in the water although no specimens were taken while egg-laying.

## PENTHOPTERA Schiner

This interesting genus includes but six described species of which *P. chirothecata* Scop., *P. cimicoides* Scop., *P. schnusei* Kuntze and *P. grisea* Riedel are Palaearctic, *P. albitarsis* O. S. is Nearctic and

*P. conjuncta* Alex. is Neotropical. Our very limited knowledge concerning the life-history of members of this genus is confined to the American form and this information may be given in the following pages.

PENTHOPTERA ALBITARSIS Osten Sacken.

*Penthoptera albitarsis* Osten Sacken; Mon. Dipt. N. Am., IV, 257, 1869.

The adult of this fly is well-known and has a wide distribution in the northeastern United States. This distribution so far as known to me, is as follows:

*Vermont,* Windham Co., Battleboro, July 15, 1908 (Johnson). *Massachusetts,* Middlesex Co., Weston, July 23, 1911 (Johnson); Plymouth Co., Plymouth, July 28, 1908 (Johnson). *Connecticut,* New London Co., New London, Osten Sacken's type. *New York,* Fulton Co., Sacandaga Park, alt. 800 feet, June 28, 1911 (Alexander); Woodworth's Lake, alt. 1650 feet, July 19, 1914 (Alexander); Tompkins Co., "The Glen," August 12, 1910 (Alexander); Sept. 17, 1907 (Needham); Coy Glen, July 11, 1911 (Alexander); Bool's Brook, July 13, 1912 (Alexander). *New Jersey,* Essex Co., Hemlock Falls, June (Weidt); Warren Co., Delaware Water Gap, July 11 (Johnson); Camden Co., Clementon, Aug. 7, 1892 (Johnson). *Pennsylvania,* (Cresson) Osten Sacken's type. *Virginia,* Southampton Co., Boykins, June 10, 1895 (Johnson); Nansemond Co., Suffolk, June 11, 1895 (Johnson); Fairfax Co., Pimmit Run, Sept. 6, 1908 (Knab). *North Carolina,* Buncombe Co., Black Mts., July 3, 1912 (Beutenmuller). *Georgia,* Rabun Co., Tallulah Falls, June 21, 1909 (Bradley).

From the above data it is seen that the fly is on the wing from June until September, being most abundant probably in July. The insects occur in cool, shady places and may be swept from the luxuriant vegetation growing in such locations.

The larva differs widely from the related Hexatomine genera in the habitat in which it dwells (in mud instead of sand and gravel); in the bright yellow coloration and in structural details; the mandible with one very broad tooth at its middle, this tooth deeply split; stigmal field surrounded by four rather short lobes, each of the

ventral pair bearing one extremely long hair; sub-caudal arrangement with the transverse rows of hairs large and comparatively few in number.

The pupa may be distinguished by the blunt breathing horns with the enlarged tips, the weak character of the hairs forming the transverse sub-caudal rows on the abdominal sternites.

The larvæ have been found in several widely separated localities and the following general statements seem to apply: It is found in rich organic soil, sometimes rather dry, at other times more saturated; in "The Glen," Ithaca, N. Y., this soil is very dark brown, in Simmons' Woods, Gloversville, N. Y., almost black in color. Their haunts are almost invariably surrounded by tall shade trees. Small streams are always near at hand and the larva may well begin its career in the water. This habitat is quite different from the sandy or gravelly situations in which the larvæ of *Eriocera* and *Hexatoma* occur. The larvæ have all of the Hexatomine characters and the quick, active movements of their relatives. However, the bright yellow coloration of the body is quite distinct from the known larvæ of the other genera. The record of the occurrence of these larvæ is as follows:

March 27, 1914—Rich organic mud was sifted to-day ("The Glen," Ithaca, N. Y.) and one larva was found in association with the larvæ of other crane-flies, *Rhaphidolabis tenuipes* O. S., common; *Rhypholophus nubilus* O. S., a few; *Molophilus hirtipennis* O. S., abundant, and other Tipulid larvæ; also a few of *Dixa modesta* Johann. (=*clavulus* Will. (?)). This larva was placed in a vial and was seen alive at various dates until June when it was no longer to be found. The vial was examined on June 30, but no part of the insect could be detected.

April 10, 1914—More of the rich organic mud from "The Glen" was examined and five larvæ found; 2 were placed in vial No. 17, 1 in vial No. 18. These vials were examined on June 30, vial 17 was spoiled; vial 18 contained one healthy larva, rather small.

April 17, 1914—More mud from "The Glen," one larva being found. Natural associates at this time were the larvæ of the following crane-flies: *Rhypholophus nubilus* O. S., *R. nigripilus* O. S.,

*R. meigeni* O. S., *Molophilus hirtipennis* O. S., these larvæ being rather common. Also several of the big white Leptid larva, *Chrysopila thoracica,* and many beetles and worms. Examined on June 30 and found to contain one healthy larva.

June 1, 1914—Rich, wet, organic mud taken from along the railroad embankment at Sacandaga Park, N. Y. This yielded a few crane-fly larvæ of the tribes *Eriopterini, Limnophilini* and *Tipulini,* as well as one of *Penthoptera.* It was placed in vial No. 52 and on June 30 emerged as an adult male.

June 9, 1914—In Simmons' Woods, Gloversville, N. Y., rich black mud from along the creek in shaded places was examined and yielded a few *Eriopterine* larvæ and one *Penthoptera.*

The immature stages may be described as follows:

## Larva

Length: Fully extended, 10-12 mm.; diameter, 1-1.2 mm.

Color bright chestnut-yellow, the cephalic half richer and deeper colored, the thoracic sclerites suffused with brown; the sub-caudal enlargement, when expanded, whitish; the skin with silky, sub-iridescent reflections.

Head-capsule rather broad, the genal plates with the inner cephalic angles rounded, and the caudal inner angle produced caudad in a long point. The labrum is quite similar to that figured for *Eriocera spinosa* (Journ. Ent. and Zool., VI, Pl. I, Fig. A, 1914). Mandibles of the usual Hexatomine type, long, slender, pointed, in a position of rest pointing caudad; the inner margin provided with teeth, a double tooth at about mid-length of the organ and a prominent knob midway between these teeth and the base of the mandible. (See Plate I, Figs. 2, 4, and 6.)

The caudal end of the body with four lobes, two being lateral and two ventral in position (Plate I, Figs. 8 and 9). The lateral lobes are provided with a dense fringe of rather short yellow hairs, these hairs directed laterad. The ventral lobes are densely clothed with long pale hairs which are directed ventrad and a few scattered longer filaments; one very long bristle from each ventral lobe, this being much longer than the segment which bears it. The stigmal disk is almost free from darker markings, a faint brown line extend-

ing from the stigma dorsad and a less distinct brown line along the ventral margin of the lateral lobe. Gills four in number, pale. The sub-caudal enlargement is provided with transverse rows of fine hairs or delicate spicules, there being about twenty-five of these rows which evidently serve as an aid to propulsion. These rows of hairs are much coarser than in related forms *(Hexatoma,* about 35 rows). The spiracles are circular, situated at the base of the lateral lobes. The body is provided with numerous long, appressed hairs. A few long hairs or short bristles on the body of which the following may be mentioned: One on the latero-dorsal margin of the last segment near the base of the lateral lobes; a series of four groups of one or two in each across the dorsal surface of the first three thoracic segments at about mid-length; a group of two or three long hairs on the sides near the caudal margin of the dorsal segments.

Described from numerous larvæ from Ithaca and Gloversville, N. Y.

## Pupa

Cephalic crest small, depressed, rather inconspicuous, each half consisting of three setiferous lobes. The breathing horns (Plate II, Fig. 4) are short and stout, red at the base and apex, the portion in between darkened and wrinkled transversely; the enlarged apex is very brittle and easily broken off. The mouth parts are about as in *Eriocera* (Plate II, Fig. 6) as figured before (l. c., Plate II, Fig. A), but the lobes of the labium are broader and more evenly pentagonal. The wing-pads extend to just beyond the tip of segment two of the abdomen; leg-sheaths extending nearly to the base of the fifth abdominal segment; the legs end about on a common level, the outer pair very slightly the longer, the inner pair a little the shorter of the three.

Sternites with the basal half feebly wrinkled transversely, the caudal half more chitinized and bearing a few weak hairs or slender spicules arranged as follows: Segment 7, two small bristles near the base and closer to the middle line; four small hairs near the caudal margin, widely separated. Segments 4 to 6 (Plate II, Fig. 7) with a sub-caudal row of rather weak slender hairs, this row

consisting of from 45 to 50 such hairs; nearer the base and closer to the median line are small hair-bearing areas with one large and one small hair, the larger being the more proximad, the other lying outside it. Segment 4 is hidden by the leg-pads but the hairs are present.

Tergites with four small tubercles on the dorsal side of the 8th segment, the more caudal pair being the larger, the cephalic pair a little smaller. Segments 1 to 7 (Plate II, Fig. 8), with six groups of hairs arranged as follows: A cephalic group near the lateral margin of the chitinized portion of the segment, consisting of two hairs; directly caudad of this group near the caudal margin of the segment, a second group of two hairs; proximad and very slightly cephalad of this latter group is a third group consisting of a large inner hair and a smaller outer one.

Segments 2 to 7 have the fleshy wrinkled pleural region rather extensive, one small hair immediately caudad of the spiracle. Eighth segment with a few scattered hairs near the caudal margin, these hairs being ventral, two pairs; lateral, one pair; subdorsal, about three pairs. Ninth segment with the tergal lobes rather conspicuous, directed sharply dorsad, the extreme tip a chitinized tooth (Plate II, Fig. 5).

Length: From crest to the tip of the abdomen, 9.2 mm.

Dextro-sinistral width at the wing-pads: About 1.6 mm.

Length of the breathing-horn: 1 mm.

Description taken from a cast skin.

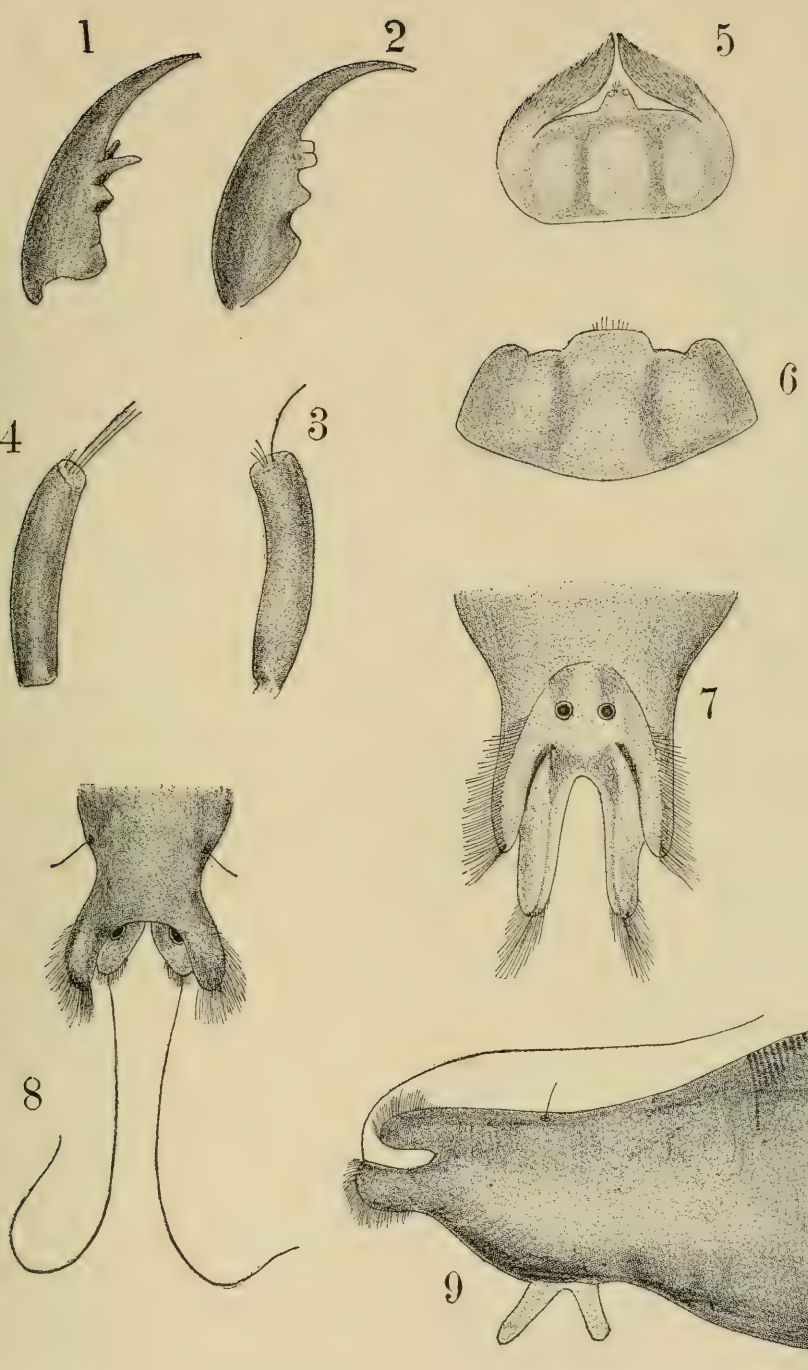
## EXPLANATION OF THE PLATES

### I. Larvæ

Figure 1. Mandible of *Hexatoma.*
Figure 2. Mandible of *Penthoptera.*
Figure 3. Antenna of *Hexatoma.*
Figure 4. Antenna of *Penthoptera.*
Figure 5. Labrum of *Hexatoma,* dorsal aspect.
Figure 6. Labrum of *Penthoptera,* dorsal aspect.
Figure 7. Dorso-caudal aspect of the end of the abdomen of *Hexatoma.*
Figure 8. Dorso-caudal aspect of the end of the abdomen of *Penthoptera.*
Figure 9. Lateral aspect of the end of the abdomen of *Penthoptera.*

### II. Pupæ

Figure 1. Lateral aspect of *Hexatoma;* male pupa.
Figure 2. Ventral aspect of *Hexatoma;* male pupa.
Figure 3. Ventral aspect of *Hexatoma;* female pupa.
Figure 4. Breathing horn of *Penthoptera;* male, dorsal aspect.
Figure 5. End of the abdomen of *Penthoptera;* male, lateral aspect.
Figure 6. Pupal mouth parts of *Penthoptera;* ventral aspect.
*a.* Labrum; *b.* maxilla; *c.* labium.
Figure 7. Sixth sternite of the abdomen of *Penthoptera,* showing the arrangement of the setæ; ventral aspect.
Figure 8. Fourth tergite of the abdomen of *Penthoptera,* showing the arrangement of the setæ; dorsal aspect.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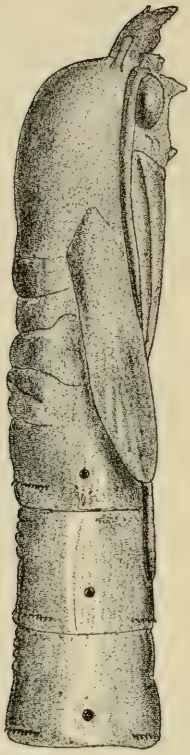

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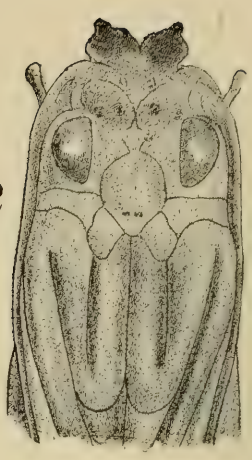

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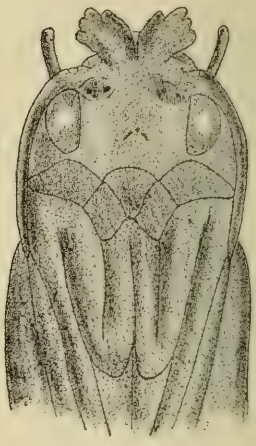

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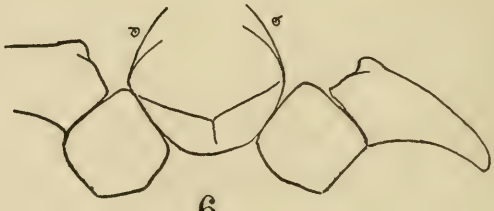

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# Some Inhabitants of the Round Gall of Goldenrod

BY CHI PING, ITHACA, N. Y.

*Introduction.*—The round gall growing on the stem of goldenrod is the home of several insects, including, besides the gall maker itself, *Eurosta solidaginis* Fitch, a number of inquilines and parasites. The fly larva starts its work on the young shoot of goldenrod during the last part of the spring, when the plant is about 2 or 3 feet high. It spends the greater part of its lifetime, including both the larval and pupal stages, in the gall. The larva may carry a parasite in at the time of its own entrance, in which case the latter will eat up its host and live inside the gall until the following spring. After the gall has started to grow, other insects which are harmless to the gall maker may get in too; they, however, do not penetrate into the central cavity, but simply make their dwelling in the common parenchyma of the walls of the gall. Most common of these is the mordellid beetle, *Mordellistina unicolor* Lec.

The galls are round and hard, with surface almost smooth when fully developed. The punctures made by the entrance of the inhabitants are not seen at all after the galls become mature. The structure on the surface does not show much difference from other parts of the stem, but sometimes the surface is fissured, due to the cracking of the epidermis. Rosin is often found on the surface of the galls, and on opening the galls a number of well filled rosin pores will always be found in the swollen common parenchyma. In the central pith a chamber is found in which lives the larva. Doubtless the rosin in the wall is highly protective against foraging birds and mammals, yet occasional galls will be found in late season drilled by woodpeckers or gnawed open by small rodents.

To the completion of this paper, I desire to express my gratitude to Dr. J. G. Needham of Cornell University, by whose suggestion and under whose supervision this work was carried on. His con-

stant sympathy, kind criticism and helpful guidance enabled me to successfully complete these observations.

*Materials.*—The round galls occur commonly on only one species of goldenrod, *Solidago canadensis.* This goldenrod grows along the roadsides, on the wet ground, especially in the open moist places near a stream and with plenty of sunshine. The galls are not always abundant; sometimes there are patches of goldenrods free from galls entirely. In some gravelly pastures, patches are found having galls on almost every stem. For the purpose of this study galls have been gathered from seven principal localities about Ithaca, viz., Cascadilla Gorge, Fall Creek Gorge, Six-Mile Creek, South Hill, Cornell Heights, Forest Home and Percy Field, on dates ranging from September, 1913, to September, 1914. The total number collected and examined is 3,300.

The first young gall was found on June 24, about 6 mm. long and 5.1 mm. wide. This is the earliest time for the galls to start growth. They reach full maturity in the last part of August. The mature galls were found first with exit holes in the last part of April.

The size of the gall in full maturity varies very much. The length varies from 16 to 36 mm., the average is about 25 mm., and the width varies from 9 to 29 mm., the average is 20 mm.

## THE FLY (*Eurosta solidaginis* Fitch)

The fly is the only one of the tenants which is responsible for the formation of the galls. It prepares the home for itself and also for several guests. It was first described by Asa Fitch in the First Report on Insects of the State of New York, 1855. The full description of the fly is in Monographs of the Diptera of North America, 1862, by H. Loew, and in the Canadian Entomologist, Vol. 24, pp. 120-123, by Rev. T. W. Fyles and W. M. Brodie. None of these has said anything regarding its life history. Its emergence from the gall has been carefully observed and described by Mrs. A. J. Snyder, as recorded in the Canadian Entomologist, 1898, pp. 99-101, but other important activities during its life, as

mating, oviposition, etc., remain unknown, and practically no one has hitherto carried on any further observation on the habits of either the larva or the adult.

*Emergence* from the galls of both the male and female adult flies was observed on May 7, 9, 11, 12, 16, 17, 26, 30 and 31. At first a little piece of the epidermis of the gall was broken off by a push from the inside. It was immediately followed by the appearance of a grayish or fleshy white bladder-like ptilinum. The ptilinum seemed to elongate itself to push its way through the very small hole previously made by the larva, and the fly struggled for a little time until the entire head was seen. The head was moving around and the ptilinum itself was expanding and relaxing. Meanwhile some minute transparent globules appeared on the surface of the ptilinum. After the entire head had come out of the hole, while the body was still within, a closer examination was made with a pocket lens. It was noticed that the ptilinum covered the entire top portion of the head and extended laterally almost over both eyes, and forward to the base of the antennæ.

Continuing to struggle for a while, the fly gradually squeezed its thorax out of the hole; however, it was still shrugging its shoulders and contracting its back in forcing out more of its body. Almost every part of its upper body, which was out of the gall now, was moving and dragging, and the transparent globules ("sweat drops") on the surface of the ptilinum were increased and decreased constantly. In one case I found the animal came out rather rapidly (it took about 3 minutes), but in others emergence was very slow (about 18-19 minutes). The animal had desperate struggle until the whole thorax and the legs were pulled out and the latter were moving for something to grasp. The difficulty was much lessened when only the abdomen was within the gall, yet a great deal of force was still required for the animal to get itself entirely liberated. The abdomen was much compressed and elongated at first. The body of the animal was much longer and the color was much paler than when mature. The wings were narrowly folded lengthwise.

Now the animal newly got into freedom was much exhausted, crawling little or staying motionless to rest itself on the surface of

the gall. The moving of the abdomen indicated gasping. The ptilinum became much smaller than when first seen, and the "sweat drops" were always present on the surface. In one of the adults a comparatively large "sweat drop" remained on the front of the face. After the disappearance of the ptilinum the head of the animal continued to contract at short intervals. The space between the eyes and ocelli was depressed and elevated. It took about 25-30 minutes for the fly to get its wings expanded.

*Mating* was observed on June 3. Several females and one male were put on a potted goldenrod, which was covered with a lamp chimney and closed with gauze. This was set on the window facing the morning sunshine. The flies, which were usually sluggish, began to be active, flying and jumping under the glass cover. Finally the male and a female came to meet each other on a leaf of the plant, the female thrust out her ovipositor at first when the male was approaching her. The male seized the female by embracing her abdomen with his middle pair of legs; the front legs were placed on the dorsal surface of the abdomen, while his hind legs were standing on the leaf surface. The ovipositor of the female was thrust into the opening at the terminal end of the abdomen of the male. Its whole length was gradually forced in. After about 20 minutes, the male began shaking and jerking and the female began moving also, then both of them became still again. Copulation lasted about 37 minutes. At the end, the female moved her hind legs and stretched them backward, trying to free herself. After a little struggle the female succeeded in freeing herself from the feet of the male. Now the connection of the fine thread-like penis (Fig. 11, Plate I) to the telescope-like genitalia of the female (Fig. 10, Plate I) was seen very clearly, the penis inserted into an opening in the penultimate segment of the female's ovipositor. The ovipositor of the female was not yet withdrawn; after a little while it began to be withdrawn, but the filamentous penis of the male was still attached to it. Finally the male freed its penis, which immediately coiled up at the terminal end of the abdomen, and then by expanding and relaxing its abdomen and rubbing its

end with the hind legs, the coiled penis was then placed retracted in its original position.

*Oviposition and egg.*—Oviposition was observed on June 2, and the long ovipositor was not used for making punctures. The egg was deposited on the surface. The female thrust out her ovipositor, which is telescope-like with a long and slender pointed tip. A single white egg was squeezed out from the opening at the end of the penultimate segment (Fig. 10, Plate I). The egg is long and somewhat spindle-shaped, one end rounded and like the larger portion of an Indian club, while the other end is capped with an obtuse micropylar projection (Fig. 2, Plate I).

*The young larva.*—On June 17, the eggs and the egg shells were found on the young shoot of the Canadian goldenrod growing in the field. I brought some of them into the laboratory and placed them in glass dishes for observing their development. From the egg shells on the young shoots, I found the tracks of the recently hatched young larva. These were made by boring, and sometimes were of considerable length. Some of the tracks ended in a little hole, showing where the larva got in. Being carefully opened, there was found a burrow leading inward directly to the central portion of the shoot, where the young larva occupied a small cavity which was newly made by it.

On June 18, I examined the eggs which were placed in the glass dishes the day before. A young larva just hatched out was boring on the young shoot not far from its abandoned shell. The larva was about 1.5-2 mm. long; it had made three holes, and was shifting to another place for boring (Fig. 1, Plate II). Its mouth parts worked like a digging hammer.

*The mature larva* is about 9 mm. long and 4 mm. broad. Its body is cylindrical with white smooth skin. It is always contracted when taken out from the gall, so the middle part of the body is broader than either end. In the front the prothoracic stigmas are laterally prominent. The cephalo-pharyngeal skeleton is black in in color (Fig. 7, Plate I). The mandible sclerites are exposed in the front of the head. There are four processes projecting back-

ward in the inside of the head. The two upper ones are the dorsal processes of the cephalo-pharyngeal sclerite, and the two lower ones, the ventral, which consist each of a loop.

The prothoracic stigmas are chitinous in structure. Each bears five digits, resembling the fingers of a hand; besides the stigma there is a spiracle (Figs. 5, 6, Plate I).

At the posterior end are two horny stigmal plates. There are three smaller oval plates on each of them. These smaller ones are much thicker, each has a slit across the middle. Close to the large stigmal plate there is a round spiracle (Figs. 8 and 9, Plate I).

*Data on season of transformation, etc.*—About 3,300 galls have been examined for studying the transformation of the fly larvæ. This study was carried from September, 1913, to the same month of the next year. All the galls examined from the beginning of this work till July, 1914, were the ones formed in the summer of 1913. In June, 1913, the new galls were starting to grow. Since then, they were also opened and examined till September. The transformations of the fly larvæ at different seasons throughout the year, including all the other occupants, are given in the following table:

TABULAR STATEMENT OF THE INHABITANTS OF 3300 GALLS

| | | Flies | | | | Beetles | | | |
|---|---|---|---|---|---|---|---|---|---|
| Dates | No. of Galls | Larvæ | Pupæ | % in Pupal Stage | Empty | Larvæ | Pupæ | Adults | Others |
| Sept., 1913... | 61 | 56 | 4 | 6 | .... | 4 | .... | .... | a |
| Oct., 1913... | 350 | 286 | 64 | 18 | .... | 34 | .... | .... | b |
| Nov., 1913... | 320 | 255 | 66 | 20 | .... | 28 | .... | .... | c |
| Dec., 1913... | 300 | 243 | 57 | 19 | .... | 18 | .... | .... | .. |
| Jan., 1914... | 250 | 208 | 48 | 19 | .... | 15 | .... | .... | .. |
| Feb., 1914... | 250 | 196 | 34 | 14 | .... | 32 | .... | .... | .. |
| Mar., 1914... | 122 | 90 | 32 | 26 | .... | .... | .... | .... | .. |
| Apr., 1914... | 143 | 122 | 39 | 39 | .... | 35 | .... | .... | d |
| May, 1914... | 520 | 28 | 461 | 90 | 31 | .... | .... | .... | e |
| June, 1914... | 224 | .... | .... | .... | 224 | .... | 2 | 2 | f |
| July, 1914... | 100 | .... | .... | .... | 100 | .... | .... | .... | g |
| June, 1914... | Young galls just starting to grow. All the galls studied hereafter were newly formed. | | | | | | | | |
| July, 1914... | 121 | 121 | .... | 0 | .... | .... | .... | .... | .. |
| Aug., 1914... | 301 | 301 | .... | 0 | .... | 6 | .... | .... | h |
| Sept., 1914... | 80 | 71 | 4 | 5 | .... | 12 | .... | .... | i |
| Total ..... | 3300 | 1977 | 809 | .... | 355 | 174 | 2 | 2 | |

a—1 Hymenopterous larva: *Eurytoma.*
b—2 Coleopterous larvæ: *Hydnocera*
c—2 Hymenopterous larvæ: *Eurytoma.*
d—Number of thrips nymphs: *Idolothrips armatus* Hood, 2 *Eurytoma* larvæ.
e—2 Dipterous larvæ, 2 adults: *Lasioptera solidaginis* O. S.; 2 *Eurytoma* larvæ.
f—*Ancistrocera tigris* Sauss; Lepidopterous pupa; *Gelechia* sp.; 1 *Eurytoma* pupa; 2 Dipterous pupæ: *Pachyopthalmus signatus* Meigen; 2 *Lasioptera solidaginis* O. S.; 3 *Lasioptera* adults.
g—4 Hymenopterous adults: *Angochlora* sp.; 2 *Halictus provancheri, Lasius umbratus* Nyl.; 2 Lasioptera larvæ.
h—1 Lepidopterous larva: Tortricid; 14 *Eurytoma* larvæ.
i—17 *Eurytoma* larvæ.

## THE BEETLE

In the galls made by the fly larvæ are often found the larvæ of the beetle, *Mordellistina unicolor* Lec., which are neither the gall makers nor the parasites, but simply live in the galls without having anything to do with the host. This beetle has been mentioned in the Canadian Entomologist, by W. H. Harrington. J. B. Smith described the adult in "A Synopsis of the Mordellidæ of the United States," Trans. Am. Ent. Soc., 1883, pp. 73-100, as also did Blatchly in Coleoptera of Indiana, 1910, p. 1322. The rearing of the species from the gall was mentioned by W. H. Ashmead in Proceedings of the U. S. National Museum for 1888, p. 611. The structure, habits and the life history have not been made known hitherto.

Observations were made on the different stages through the whole year, especially on the activities of the adult during the last part of the spring and the first part of the summer. The larva lies in a narrow tunnel which is just wide enough for containing its body. The tunnel is more or less winding, made in the common parenchyma, but never in the center of the gall. In most cases a single larva lies therein, sometimes two are found in one tunnel, and also more than one tunnel is found in the same gall, either communicating with each other, or separated. In filling up a part of the tunnel some dry, dust-like substance is deposited; this is the waste material made by the larva (see fig. 3*b* of Plate 1). In a few cases the larva was found in the central cavity. The larva lives in the gall from the summer to following spring. The beetles were first seen on June 8. Afterwards I reared a number of them from the galls kept in the breeding jars. They were found in the field till the first part of August.

*Mating.*—Several beetles were put in an 8-ounce bottle, placed on the window toward the sunshine. They were flying and jumping actively. At first a male came to a beetle (sex unknown), jumping upon the front of the latter, trying to mate, with its genitalia stretching out and bending downwards. The latter was unresponsive. Afterwards, the vigorous male desisted, and wandered

elsewhere. Finally it found a female and grasped it to mate, its genitalia was stretched and bending downward somewhat like a sickle, and the female had its genitalia stretching out quite straight. Copulation took place; it lasted only one and a half minutes, and then they separated.

*The eggs.*—I put several beetles, both males and females, in the 8-ounce bottle, in which two young galls and two or three young leaves of the goldenrod were placed. They had been looked over carefully before they were placed in, in order to make sure that there was nothing on the surface of the galls and leaves. From time to time I examined them by taking them out of the bottle. On June 30, I found two eggs on the surface of the gall. The outline of the egg is not oval, nor regularly elongated, but rather irregular. Its larger end is rather roundish, blunt, while the narrower and pointed end is somewhat attenuate (see fig. 2 of Plate 2).

*Oviposition.*—On July 9, about 7 o'clock in the morning, I found the female endeavoring to oviposit on the surface of a gall growing in the field, though it did not lay eggs at all; on account of the hardness of the epidermis of the gall, it was unable to make a puncture. The beetle tried several times to puncture the surface, especially at the place near the petiole of leaves growing on the surface of the gall. It thrust out its ovipositor, bending downward to puncture the surface and trying several times on the surface of the leaves too, then the beetle flew away from one plant to another and jumped away again and finally it was lost to my sight.

From the beetle's endeavor in laying eggs, from the eggs laid by the beetles in the laboratory, and also from the eggs found in the field, which have been identified by comparing them with those laid in the laboratory, I understand why these eggs are always embedded with their larger end on the surface of the gall, though not particularly deep. The female beetle makes a very shallow hole, just enough for embedding a part of the larger end of the egg, while the pointed end does not touch the surface of the gall at all. The egg hatches out in such condition, the young larva crawls on the surface and makes its way into the gall by boring on the epidermis from the

outside. The slight embedding of a portion of the end gives a great deal of stability to the attachment of the egg to the surface of the gall.

*Entrance of larva into gall.*—On July 7, on the surface of the young gall, which was brought into the laboratory from the field on July 2, for observing the development of the egg on it, I found the broken egg-shell. Close by it a young larva was boring into the epidermis, its head had bored in, its abdomen was still without, and the latter was moving around. When the larva was carefully removed, an admirable round hole on the surface of the gall was seen. An advanced stage was found on August 4, the larva had itself entirely got in the gall, and lived in a small tunnel made in the common parenchyma, leaving a hole on the epidermis, which was destined to be closed up sooner or later after the gall had grown older.

*Larva.*—At time of hatching the larva is about .5 mm. long and .2 to .25 mm. broad. Its body is very soft and almost transparent. The segments of the body are not very distinct, except when examined under a microscope. The head and the abdominal regions are thinly covered with some fine hairs, and the head is much broader than either the thorax or the abdomen. The eyes, which appear as black spots on both sides of the head, are very conspicuous, each eye consisting of two black spots, which are adjacent to each other (Fig. 6, Plate II), and the mouth-parts brownish in color can be seen from the ventral side.

An advanced stage of the larva was found in a shallow tunnel in a young gall. The hole on the surface, through which the larva got in had not been closed up. This shows that the animal got in not very long previously. The larva at this stage is about .9 to 1 mm. long and .33 mm. broad. The skin is darker and more opaque, and the segments are more distinct than when just hatched out. Its head is broader than either thorax or abdomen and in general its shape is roundish. More pronounced are the hairs covering the head and the abdomen. On account of the well developed mandibles and maxillæ the mouth-parts are very clear to view. The forked abdominal end had not been much chitinized.

The mature larva found in the gall is about 7 to 8 mm. long and 1.9 mm. broad. Its color is whitish to pale yellow, occasionally light pinkish. Its body is thinly covered with hairs which are slightly brownish, especially on the head and abdomen. The legs are not much elongated. They look like blunt, lobular, fleshy projections. The dorsum of both thorax and abdomen has its surface somewhat wrinkled. On the sides are found two rows of lobes of the skin, extending from the prothorax to the abdominal end. Now the forked abdominal end is horny in structure. The mandibles are large, pointed at the tips and broadened at the base. The labrum is very small compared with other parts of the mouth. The other parts are not so much chitinized as the mandibles. The maxillary palpi, galea, stipes, ligula, etc., are thin and light brown in color (Fig. 5, Plate II).

*Pupa.*—At the beginning of pupation the body of the animal is soft and the pupal skin is perfectly white. Neither similar to the larva nor to the adult, the mouth-parts of the pupa have the maxillæ much longer than the mandibles. Except the tips of the mandibles, which are slightly chitinized, the entire mouth-parts are soft. The antennæ are placed latero-dorsad and their segments are not very distinctly visible. The compound eyes have been developed within the pupal skin. Both elytra and inner wings are hollow, sheath-like, more or less convex-flattened and gradually narrow up towards their tips. The legs have been developed in their full length and the hind ones are placed crosswise on the ventral side. The abdomen has transformed to the general shape of that of the adult within the transparent skin (Fig. 4, Plate II).

When the pupa is getting old its color becomes darker, especially on its head. The elytra and the inner wings now are placed latero-ventrad. The eyes, antennæ, mouth-parts, legs, and the elongated tail-like abdomen are brownish black, like those of the adult.

*Data on occurrence, season, etc.*—The beetle has its larval stage much longer than either the adult or the pupal. The first occurrence of the larva just hatched out from an egg on the surface of

the gall, was recorded on July 7, since then the larvæ were often found in the galls. This stage lasts from July to May of next year. (Sometimes the larva delays pupating even in the late summer, but this is very rare.) The pupa was first found in the first part of June. After this I found several pupæ for the remainder of the month, few found in the last part of June, however, were much advanced. A number of beetles have been reared from the galls in the first part of June; this shows that the pupation of the beetle must begin in the last part of May and first part of June. The adult beetles appear in the first part of June, and continue to live outside the galls till the first part of August. The eggs were found on June 24, 30, July 5, etc., till the first part of August.

## OTHER OCCUPANTS

Besides the flies, the gall makers, and the mordellid beetles, there are representatives of several orders of insects. Three are parasites, while all the rest are of uncertain position. Numbers of each found are given in the Table on page 9.

*Eurytoma gigantea* Walsh, parasitic on *Eurosta solidaginis* Fitch.

*Eurytoma* sp., parasitic on *Eurosta solidaginis* Fitch. These were determined by Mr. J. C. Crawford. They eat up the host in the central cavity of the gall, pass their larval and pupal periods within; they emerge, as adult, a little later than the fly.

*Ancistrocera tigris* Sauss, a larva found in the central cavity of a gall on June 23, pupated on June 25 and became adult on July 5. This gall had no hole on its surface. This parasite was determined by Mr. Rohwer.

*Lasius umbratus* Nyl, an adult found in a deserted gall and determined by Mr. Rohwer.

*Halictus provancheri,* found in a deserted gall. Two adults lived in the same central cavity. They were determined by Mr. J. C. Crawford, who states that these have nothing to do with galls.

*Augochlora* sp., found in a deserted gall and determined by Mr. J. C. Crawford, who states that it has nothing to do with galls.

*Lasioptera solidaginis* O. S., determined by Dr. E. P. Felt, who states that it is a rather common form about New York City, Albany, Worcester, Mass., and Boscawen, N. J., wintering normally in the gall, the midges appearing in the spring. There is probably but one generation. It happens that a number of the Lasopterariæ live in the subcortical tissues, which must be firm at the time of oviposition.

*Pachyophthalmus signatus* Meigen, reared from a pupa found in the central cavity of a gall which had no hole on its surface. It was determined by Mr. Walton, who states that it is parasitic on the mud wasps (*Trypaeylon politum* Say and *Pelopaeus cemetarius*).

*Gelechia* sp., reared from a pupa found in the gall which had no hole on its surface. It was determined by Mr. Busck.

*Tortricid* larva, found in the common parenchyma of a young gall and determined by Mr. Busck, who states that it is a borer, boring up the stem into the gall.

*Hydnocera* larva found in the common parenchyma of a mature gall and determined by Mr. H. S. Barber. This is probably one of the wood-boring species of *Cleridæ* and predaceous in both larval and adult stages. The larva enters the home of its prey to feed on the early stage.

*Idolothrips armatus* Hood, a number of nymphs found in a deserted gall. This gall was decaying. They were determined by Mr. Hood.

## SUMMARY

1. The round gall of the Canada goldenrod is found in abundance on stems that grow in open moist ground. They are caused by the larva of the fly *Eurosta solidaginis* Fitch. They are tenanted also by the larva of the beetle, *Mordellistina unicolor* Lec., and by parasites of both fly and beetle. After the emergence of these the empty galls afford shelter to a number of chance visitors.

2. The galls vary from 16 to 36 mm. in length and from 9 to 29 mm. in width.

3. The adult fly emerges from the gall in May.

4. In mating, the female inserts its ovipositor into the male's abdomen, the copulation lasts (in the case observed) about 37 minutes.

5. The female lays the egg by squeezing it out through the penultimate segment of its ovipositor, but does not use the ovipositor to make any puncture on the plant.

6. The larva bores from the outside into the inside of the young shoot, causing the growth of a gall.

7. The transformation of the fly in the galls extends over a considerable period, 17% being found in the pupal stage through the fall and winter, 32% in the early spring, 90% in mid-spring, and adult in late spring.

8. The adult beetle (*Mordellistina unicolor Lec.*) appears in June.

9. The mating of the beetles lasts about one-half minute.

10. The female oviposits on the surface of a gall by making a very shallow hole in which to embed the broad end of the egg.

11. The egg has an irregular outline, with an attenuately pointed end.

12. The larva gets into the gall by boring a hole on the surface. When about a day old it is .5 mm. long, and when grown it is 7-8 mm. long, 1.9 mm. broad.

13. The larval period lasts from July to May of the following year.

14. The pupation takes place in the latter part of May and first part of June.

15. The eggs laid are found from last part of June till first part of August.

16. The other occupants of this gall are *Eurytoma gigantea* Walsh, *Eurytoma* sp., *Lasioptera solidaginis* O. S., *Pachyopthalmus signatus* Meigen, *Tortricid* caterpillar, *Hydnocera* sp., *Lasius umbratus* Nyl., *Ancistrocera tigris* Sauss, *Idolothrips armatus* Hood, *Gelechia* sp., *Halictus provancheri, Augochlora* sp.

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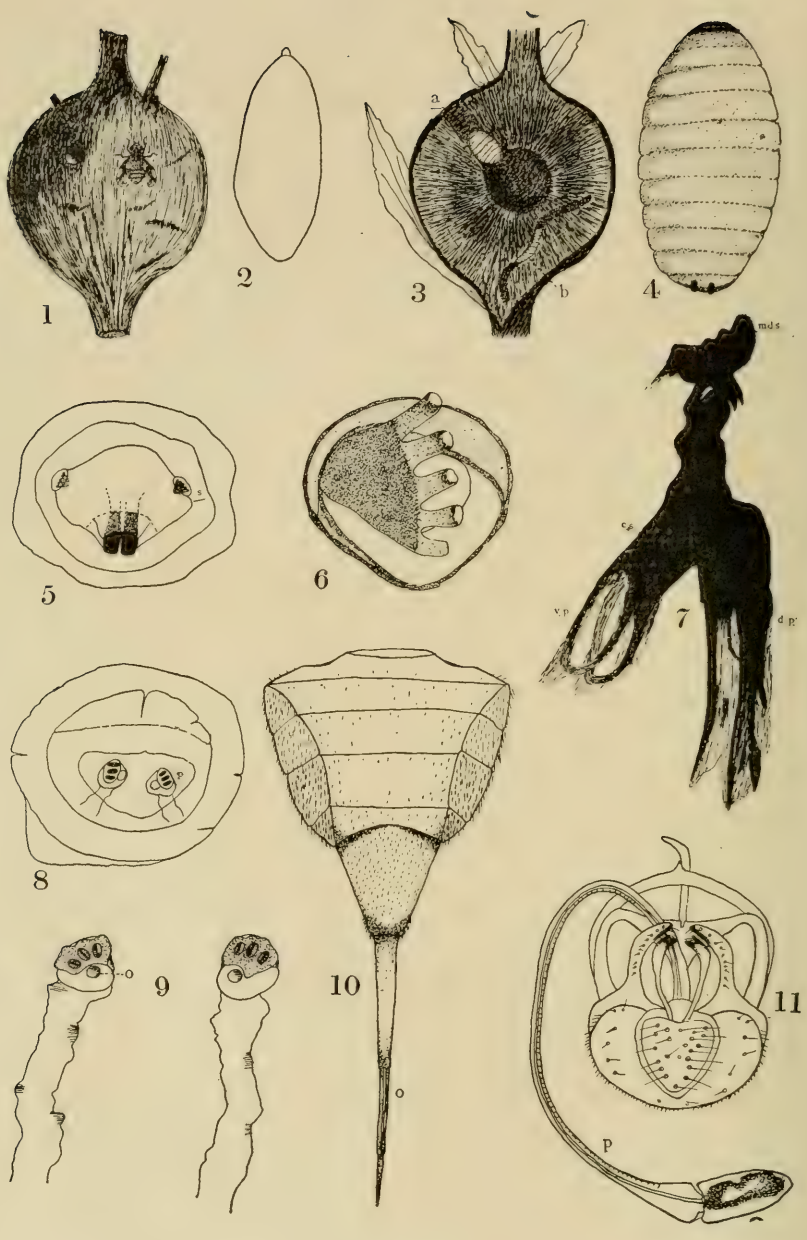
## EXPLANATION OF PLATES

### Plate I

Figure 1. Gall, natural size, with a hole on its surface and a fly by it.
Figure 2. Egg of the fly, greatly enlarged.
Figure 3. Longisection of a gall, showing the central cavity; *a.* fly larva, and *b.* beetle larva in tunnel.
Figure 4. Fly puparium, dorsal view.
Figure 5. Front of fly larva; *s.* prothoracic stigma.
Figure 6. Prothoracic stigma, greatly enlarged.
Figure 7. Cephalopharyngeal skeleton, *mds.* mandible sclerite; *d.p.* dorsal process, *c.s.* cephalopharyngeal sclerite, *v.p.* ventral process.
Figure 8. Caudal end of fly larva, *p.* stigmal plate.
Figure 9. Stigmal plates, greatly enlarged, *o.* spiracle.
Figure 10. ♀ Abdomen, *o.* genitalia.
Figure 11. ♂ Genitalia, *p.* penis.

### Plate II

Figure 1. Young shoot of goldenrod; *a.* egg-shell, *b.* track, *c.* young fly larva boring hole.
Figure 2. Beetle egg, greatly enlarged.
Figure 3. Beetle larva, oblique lateral view.
Figure 4. Beetle pupa, ventral view.
Figure 5. Labium of beetle larva; *mxp.* maxillary palpus, *s.* stipes, *g.* galea, *l.* ligula, *p.* palpus.
Figure 6. Head of beetle larva, dorsal view.
Figure 7. ♀ Abdomen with genitalia, ventral view.
Figure 8. ♂ Abdomen with genitalia, ventral view.
Figure 9. ♂ Abdomen with genitalia, lateral view.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# Aphididæ of California. XI*

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## A New Lachnus Attacking the Japanese Dwarf Silver Spruce

*Lachnus glehnus* n. sp.

(Figs. 1-3)

This species is of medium size and often occurs in great numbers upon the host. It was so abundant in the Capitol Park, Sacramento, California, during the summer of 1912 that control measures were adopted to suppress it. Though the species was abundant upon two trees in the park, it was not found attacking any of the numerous other conifers in the immediate vicinity, showing that it has a decided preference for the one host, the Japanese dwarf silver spruce, *Picea glehni* Mast., which is said to have been imported from Japan a number of years ago. There is no tangible way of accounting for its presence upon this particular tree other than it may have been imported from Japan along with the young plants and have persisted upon them ever since. It has some characters common with *Lachnus ponderosa* Williams, as will be seen in examining the differences pointed out by John June Davis near the end of the article.

The following description is based upon two selected individuals, a winged and an apterous viviparous female, which have been designated as types. In addition to these the writer has examined 28 mounted winged viviparous females and 37 mounted apterous viviparous females. Unless otherwise stated the descriptions will refer only to the type specimens.

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* This is a continuation of the series of articles entitled "Aphididæ of Southern California" by the same author.

(Fig. 1)

WINGED VIVIPAROUS FEMALE

*General appearance:* The general appearance and shape of the body are well shown by the photograph (Fig. 1) which illustrates especially well the white powdery covering arranged in somewhat definite pattern on the dorsum. The body is rich amber-brown in color, but cannot be seen except by removing the powdery covering.

Fig. 1—*Lachnus glehnus* n. sp. Photograph showing a colony on a small twig at the left and the general appearance of the various forms at the right. (Original.)

*Size:* The size is about average of the members of the genus, the length being 3.5 mm. and the width at the bases of the cornicles, 1.9 mm. *Head:* Considerably wider than long, dusky amber in color with very distinct longitudinal, median suture. *Eyes:* Large, very dark red to almost black and with very small lateral tubercle at the posterior margin. *Antennæ:* Rather short, reaching just beyond the thorax, curving slightly toward the front when at rest;

dusky throughout except the base of article III, which is amber. The length of the articles of the right member are : I, 0.08 mm.; II, 0.09 mm.; III, 0.34 mm.; IV, 0.16 mm.; V, 0.2 mm.; VI, 0.17 mm.; total, 1.04 mm. When held bent in natural position the length from the base to the tip, measuring straight across, is 0.98 mm. The length varies considerably with the individuals, as will be seen by comparing the drawings (Fig. 3B), which are made to the same scale, and by comparing the two members of the same individual. The sensoria are few, but quite large and circular in shape. They are distributed as follows:

| | Article III | Article IV | Article V |
|---|---|---|---|
| Right member | 4 | 1 | 2 |
| Left member | 4 | 2 | 2 |

In nearly every case the sensoria are confined to the apical portion of the articles—to the apical two-thirds or half of III and near the tip of IV and V. There is considerable variation in both the number and location of the sensoria, as will be seen in Fig. 3B. The tabulated results showing the number and position of sensoria in a number of specimens are given below, as follows:

| Article | Number of sensoria | Number of articles |
|---|---|---|
| III | 1 | 1 |
| | 2 | 11 |
| | 3 | 18 |
| | 4 | 13 |
| | 5 | 3 |
| | 6 | 1 |
| IV | 1 | 17 |
| | 2 | 29 |

In no case was article V noted with more or less than two. They are sometimes located slightly different and often one is larger, but the number is constant. All the articles are clothed with long hairs. *Prothorax:* Very short and scarcely wider than the head, nearly black above and dark amber on the sides and ventral surface. *Mesothorax and Metathorax:* Muscle-lobes black, sides dark amber, ventral surface black except immediately around the coxæ.

There appears to be a small lateral tubercle on the side of the mesothorax near the front at the base of each primary wing. *Abdomen:* Dark reddish-brown with dark spots on the sides and dorsum, widest at the bases of the cornicles. *Cornicles:* Very short and thick as shown in Fig. 2, E, very hairy, black, length 0.22 mm., width 0.38 mm. *Legs:* Normal in size, all dark except the bases of the femora and the middles of the tibiæ which are light amber, hairy, hind tibiæ distinctly bowed inwardly, first tarsal joint about half the length of the second (Fig. 2, F and Fig. 3, C). *Wings:* The wings are rather slender, hyaline with dusky amber veins. (Fig. 2, A and Fig. 3, A.) *Primary:* Medium in size with normal venation. Costal and subcostal veins wide. Stigma dusky brown, long

(Fig. 2)

and narrow with the opposite sides nearly parallel. Stigmal vein wide and distinct at base becoming narrower towards the tip; slightly curved inwardly toward front margin. First and second discoidals distinct, the first straight and the second slightly curved. Third discoidal very indistinct, slightly curved; first fork one-third the distance from the base to the tip; second fork not quite one-half the distance from the first fork to the tip. There are small faintly clouded areas at the tips of the stigmal and discoidal veins as shown in the illustrations. Length, 3.6 mm.; width, at the tip of the second discoidal, 1.2 mm. *Secondary:* All of the veins are distinct and dark amber in color. Subcostal slightly bent as shown in the drawings. Discoidals with bases quite far apart, the first arising about one-fifth and the second two-thirds the distance from the base to the tip of the subcostal. There are also small dusky areas at the tips of these veins. Length 2.3 mm.; width near the middle, 0.7 mm. *Cauda:* Dark or nearly black around the margins, short, rounded and hairy.

The entire body is thickly clothed with quite long hairs, which are very noticeable.

### Apterous Viviparous Female

*General appearance:* The body shape is much like that of many species of this genus, being distinctly pyriform and widest at the

bases of the cornicles and narrowest at the head. The color of the body proper is deep amber or reddish-brown. The surface is covered with a very fine whitish powder which is arranged more or less definitely as shown in the photograph (Fig. 1), and which gives a decided gray color to the insect. *Size:* Length, 3.5 mm.; greatest width, 2.1 mm. *Eyes:* Dark red. *Head:* Dark reddish-brown with black front and black spots on the dorsum. *Antennæ:* Dusky, excepting the base of Article III which is light amber. They are curved inwardly and reach about to the middle of the meta-

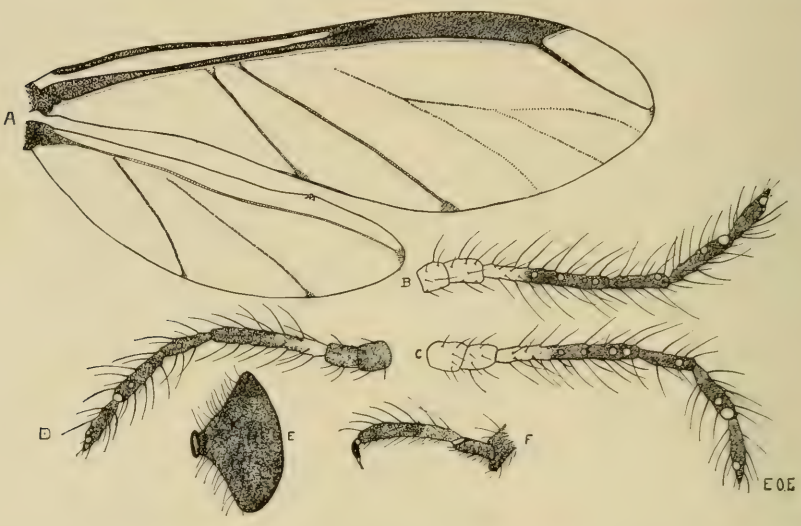



Fig. 2—*Lachnus glehnus* n. sp. A, wings of winged viviparous female; B, right and C, left antenna of winged viviparous female; D, antenna of apterous viviparous female; E, cornicle of winged viviparous female; F, hind tarsi of winged viviparous female. All of type specimens. (Original.)

thorax; hairy; the length, when held in a natural position, from the base to the tip is 0.81 mm.; the length when straightened is 1.26 mm.; the lengths of the articles are as follows: I, 0.09 mm.; II, 0.08 mm.; III, 0.31 mm.; IV, 0.14 mm.; V, 0.18 mm.; VI, 0.16 mm. The lengths vary considerably with other individuals. The sensoria are arranged on the type specimen as follows: One large sensorium near the tip of IV, two large ones (the apical one

largest) near the tip of V, and several in the process of VI. Of other individuals examined the results may be tabulated as follows:

| | | |
|---|---|---|
| III | 0 | 20 |
| | 1 | 4 |
| IV | 0 | 2 |
| | 1 | 22 |
| V | 2 | 24 |

*Rostrum:* Reaches to the base of the abdomen; dark excepting the basal third which is amber. *Thorax:* Dark amber with black spots around the spiracles and on the dorsum arranged in transverse rows. *Abdomen:* Dark amber or reddish-brown, with black markings around the spiracles and black spots along the sides. *Legs:* Average in size, differing in no important respects from those of the winged form. *Cornicles:* Greatly resemble those of the winged form in size and shape as shown in Fig. 2, E. The area around the base is more mottled and not uniformly dark as in the winged form. *Cauda:* Rounded, hairy, dusky around the margins.

## Young

The immature forms vary from very light yellowish or amber to dark amber and may or may not be covered with the whitish powder.

## Food Plant

This species feeds upon the bark of the small twigs of the Japanese dwarf silver spruce, *Picea glehni* Mast. The insects are often so abundant as to entirely cover the small branches.

## Locality

This species has only been taken from two trees growing together in the Capitol Park, Sacramento, Cal., near the east entrance of the Capitol Building. The trees are said to have been imported from Japan and it is possible that the insect in question was imported with them.

(Fig. 3)

## Date of Collection

The insects are most abundant during the spring and summer and were especially numerous during those months in 1912 and 1913. Serial number 62.

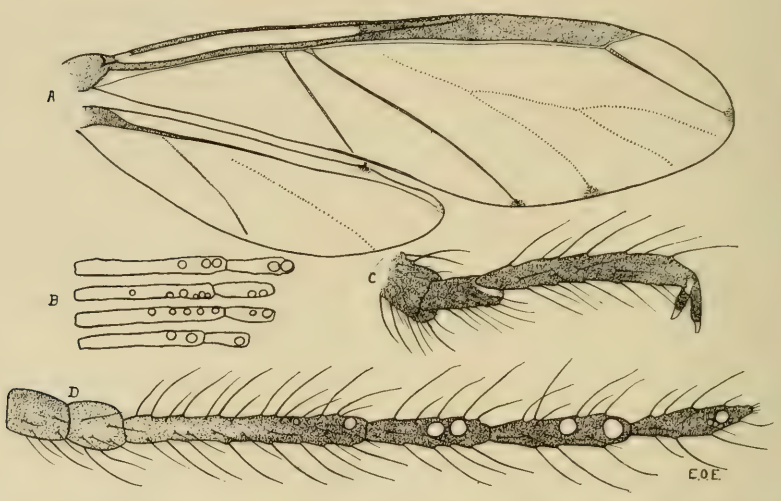



Fig. 3—*Lachnus glehnus* n. sp. A, wings of winged viviparous females; B, antennal articles III and IV of various winged viviparous females; C, tarsi of hind leg of winged viviparous female; D, antenna of winged viviparous female. From cotypes. (Original.)

## General Considerations

Before preparing this description the writer sent specimens to many of the leading workers of the *Aphididæ* in the United States and it was not until after hearing from these that the work was undertaken. Some of these workers have made some very good suggestions which I am very glad to record as follows:

"Your No. 62, collected on *Picea gléhni* seems to be sufficiently distinct from *Lachnus ponderosa* to call it a different species. So far as I can make out from what I know of the Lachnids off hand it is a new species. It is remarkably close to *ponderosa* but one notices from the first that the hairs on the legs of *ponderosa* are comparatively short and more or less spine-like while those on the legs of

No. 62 are rather long, noticeably longer than those on the legs of *ponderosa*. In the wingless forms I notice the following differences: cornicles of *ponderosa* larger than No. 62. Hind tibia of *ponderosa* relatively longer than in No. 62. In the former antennal segment VI is about two-thirds the length of V, while in No. 62 these two segments are subequal (or nearly so). I could not make out the sensoria on the specimens you sent, but in *ponderosa* there is one sensorium on III, one on IV and one or two on V. Also the total antennal length of *ponderosa* is relatively greater than in No. 62. In the winged individuals the head of *ponderosa* does not appear to be nearly as hairy as the head of No. 62 and the eyes of the latter appear to be more pedunculated. As in the wingless the hind tibia of *ponderosa* is comparatively longer than in No. 62 and the antennæ have slight differences, but I do not know that they are dependable."—John June Davis, Lafayette, Indiana, April 23, 1913.

"No. 62 from Japanese spruce appears to me to be different from all the species I am acquainted with and based upon a superficial study, I would say that it is new."—H. F. Wilson, Corvallis, Oregon, March 15, 1915.

## THE MANZANITA LEAF—GALL APHIS

*Phyllaphis coweni* (Cockerell)

(Figs. 4-7)

### Synonomy and Bibliography

Aphid, Cowen, J. H.—Bul. No. 31, Tech. Ser. No. 1, Colo. Agrcl. Exp. Sta., p. 125, 1895.

*Pemphigus coweni* Cockerell—Cockerell, T. D. A., Can. Ent., XXXVII, p. 391, 1905.

*Phyllaphis coweni* (Cockerell)—Gillette, C. P., Can. Ent., XLI, p. 41, 1909.

*Cryptosiphum tahœnse* Davidson—Davidson, W. M., Jr. Ec. Ent. IV, p. 559, 1911.

Though this species is very common and abundant, producing large conspicuous red galls upon the leaves of manzanita, it has

been the cause of much confusion as is evidenced by the number of times it has been described as a new species. This confusion has been largely due to the peculiar body structure which has made its classification somewhat difficult.

Fig. 4—Photograph of manzanita branch showing the galls on the leaves made by the manzanita leaf-gall aphis, *Phyllaphis coweni* (Cockerell). Natural size. (Original.)

Because of its abundance throughout the state and the many inquiries received regarding it a description in a local publication will undoubtedly be welcomed.

### Stem Mother

(Fig. 5)

During the late summer and fall of the year the young leaf galls appear in great numbers upon the manzanita bushes as a result

of the attacks of the stem mothers which are numerous at that season and which are busily engaged in giving birth to the succeeding generations. These individuals are easily recognized by their broadly pyriform or robust bodies which are sometimes partially covered with much or little white cottony secretion. The color of the body varies from amber-brown to dark olive-green with dark broken

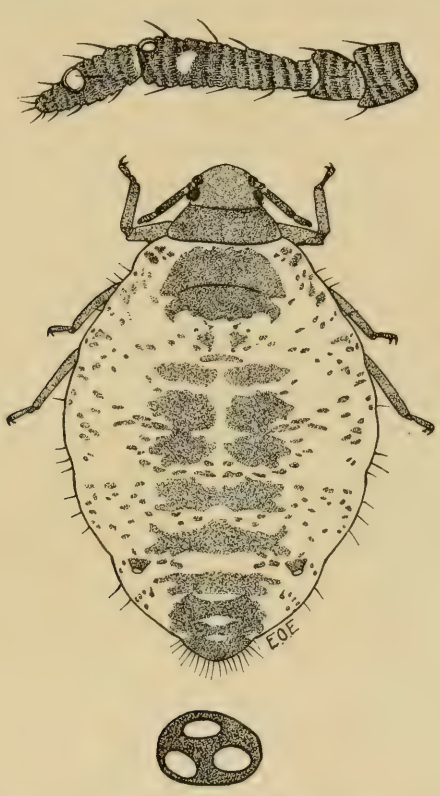


Fig. 5—*Phyllaphis coweni* (Cockerell). Stem mother with enlarged drawing of an antenna at the top and a compound eye at the bottom. (Original.)

transverse bands on the dorsum as shown in Fig. 5. The entire body is covered with many very short hairs. The usual length varies from 1.5 mm. to 2 mm. and the greatest width from 0.6 mm. to 1 mm. The head is small and narrower than the prothorax. The compound eyes are small and consist of three fecets each which

resemble groups of ocelli. They are dark red. True ocelli are not visible in the writer's specimens. The antennæ are short, scarcely reaching to the base of the prothorax; dusky; the entire surface covered with very short spine-like hairs arranged in concentric rings, and a few longer hairs; 4-articled (in some specimens there is an indication of a division in article III, making 5 articles). The lengths of the articles are approximately as follows: I, 0.05 mm.; II, 0.04 mm.; III, 0.15 mm.; IV, 0.09 mm.; total, 0.33 mm. The sensoria are few, nearly circular and distributed as follows: one large circular one near the tip of III and several smaller ones in the process of IV (there is also usually a noticeably clear semi-circular area, free from the small spines near the middle of III which has the appearance of a sensorium, but which is evidently not one). The thorax gradually widens from the head and is of the same general color as the abdomen. The abdomen is broadest at the middle or near the posterior end, marked with dark, broken transverse bands on the dorsum. The cornicles are short, scarcely extending above the surface of the abdomen, noticeably wider at the base, dark, hairy, located near the posterior end on the 6th abdominal segment. In many specimens the writer was unable to locate cornicles at all and is led to believe that they are not present in all specimens. Dr. Cockerell mentions the absence of cornicles in specimens taken by him. The legs are short and rather frail-looking for the size of the body, hairy and dusky. The cauda is broadly rounded, dusky and quite hairy.

### Winged Oviparous Female

(Fig. 6)

The general color of the winged oviparous female is dark olive-green, with the muscle lobes, nearly all of the head, antennæ, legs and the markings on the dorsum of the abdomen dusky or black. There is a lateral mass of white cottony wax on either side of the abdomen designated by the dark areas in the vicinity of the cornicles shown in the drawing (Fig. 6). The normal length ranges from 1.5 mm. to 1.8 mm. and the width from 0.6 mm. to 0.8 mm. The head

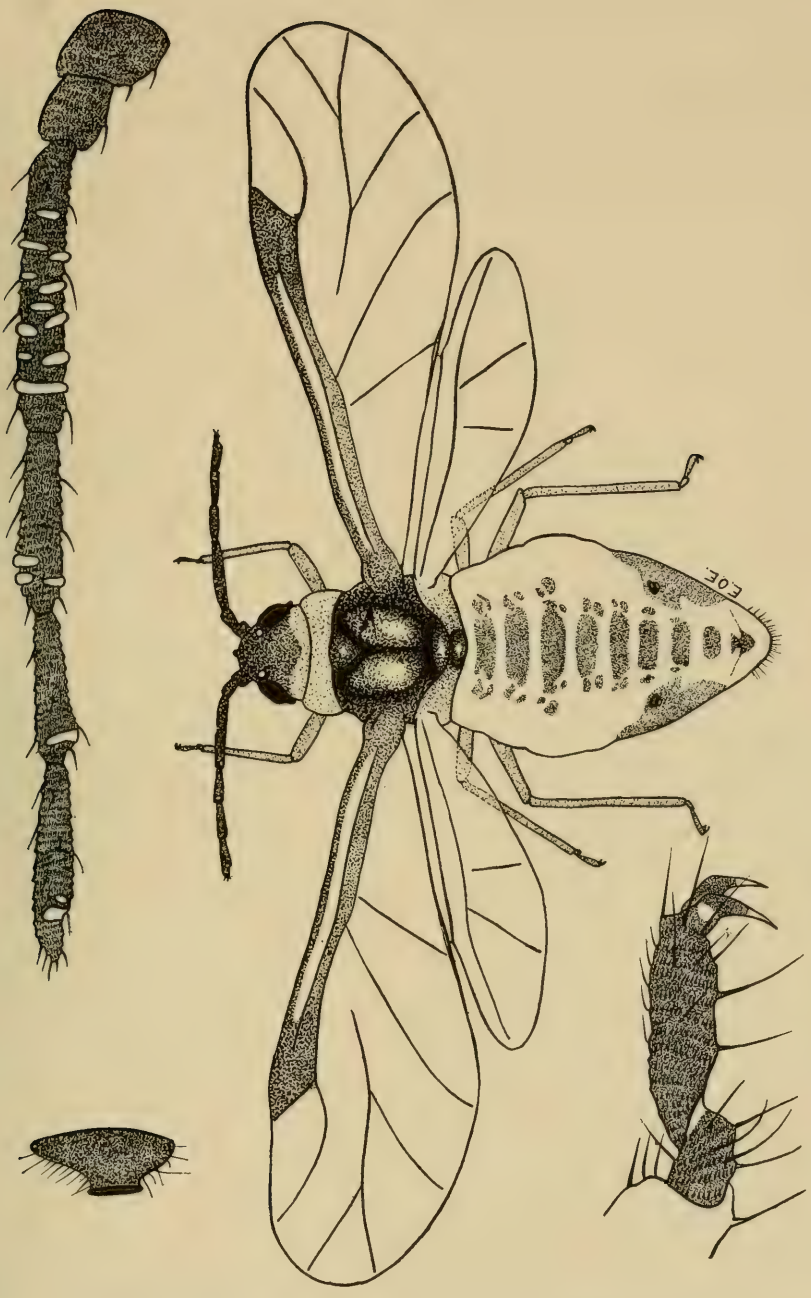


Fig. 6—*Phyllaphis coweni* (Cockerell). Winged oviparous female with detail drawings of the antenna, cornicle and hind tarsi. (Original.)

is dusky-black excepting the base which is olive-green; only slightly narrower than the prothorax. The eyes are dark red or brown with well developed lateral tubercles. The antennæ are dusky brown or nearly black with numerous concentric rows of short dark spines as in the stem mother and all other forms of this species; 6-articled; few normally long spines. The lengths of the articles are as follows: I, 0.055 mm.; II, 0.05 mm.; III, 0.23 mm.; IV, 0.13 mm.; V, 0.12 mm.; VI, 0.14 mm.; total, 0.725 mm. The length varies with the size of the adult and the measurements may differ considerably from those given above. The sensoria are large, transverse and vary somewhat in number and location. Of a large number of specimens examined the following tabulations are normal: III, from 8 to 15; IV, from 1 to 5; V, 1; VI, 2. The thorax is dark olive-green with the muscle lobes black. The abdomen is dark olive-green with irregular dark-brown or nearly black markings as shown in Fig. 6. In the living forms a white cottony wax is secreted from the sides near the cornicles and partially hides the body. The cornicles are very short, wider than long, hairy and black. The wings are hyaline with dusky-amber veins. The primary wings are 2 mm. long and 0.7 mm. wide. The venation is shown in Fig. 6. The secondary wings are narrow, 1.2 mm. long and 0.3 mm. wide. The legs are rather small, dusky-brown with few hairs. The cauda is broadly rounded with long spine-like hairs.

### Winged Viviparous Female

The size, color, shape and general appearance are much the same as the winged oviparous female just previously described. The white waxy secretions of the abdomen, however, are wanting and the dark markings on the dorsum of the abdomen are often very indistinct. In some specimens the tips of the middle and hind tibiæ are noticeably enlarged.

### Immature Forms

The immature forms are almost transparent and colorless when first born, but gradually assume a yellowish-green and finally an amber or dark olive-green color with the markings of the adult forms.

## Male

(Fig. 7)

The male is only about half as large as the other forms and is usually easily recognized by the small size and slender yellowish body.

The front and lateral margins of the head, antennæ, legs, muscle lobes are dusky and the remainder of the body varies from yellowish in most individuals to pale yellowish-green in others. Occasionally the posterior end of the abdomen is faintly dusky. The length is about 0.85 mm. and the width 0.3 mm. The head is nearly as wide as the prothorax with the front and lateral margins dusky. The eyes are red. The antennæ are dusky, 6-articled, entirely covered with many transverse or concentric rows of very small spine-like hairs. The lengths of the articles are about as follows: I, 0.015 mm.; II, 0.012 mm.; III, 0.063 mm.; IV, 0.035 mm.; V, 0.033 mm.; VI, 0.034 mm; total, 0.192 mm. The sensoria are transverse and vary from 5 to 7 on article III, one on each of article IV and V and two or more on VI. The prothorax is slightly wider than the head, yellow with dusky or nearly black muscle lobes. The abdomen is pale yellow or greenish throughout, except that the posterior tip is sometimes dusky. The cornicles are evidently absent as the writer was unable to locate any in eight mounted specimens. Professor Gillette does not figure or mention them in his description. The wings are hyaline with the stigma and the costal and subcostal veins prominent. The primary wings are about 1.4 mm. long and 0.5 mm. wide. The secondary wings are about 0.76 mm. long and 0.2 mm. wide. The venation is shown in Fig. 7. The legs are rather long and dusky-yellow in color. The cauda is blunt, dusky and has many long hairs.

## Food Plants

This insect appears to confine its attacks entirely to different species of manzanita, there being none of the species of this plant immune so far as the writer has observed. In Colorado the common species is called bearberry *(Arctostaphylos uva-ursi)*. In California

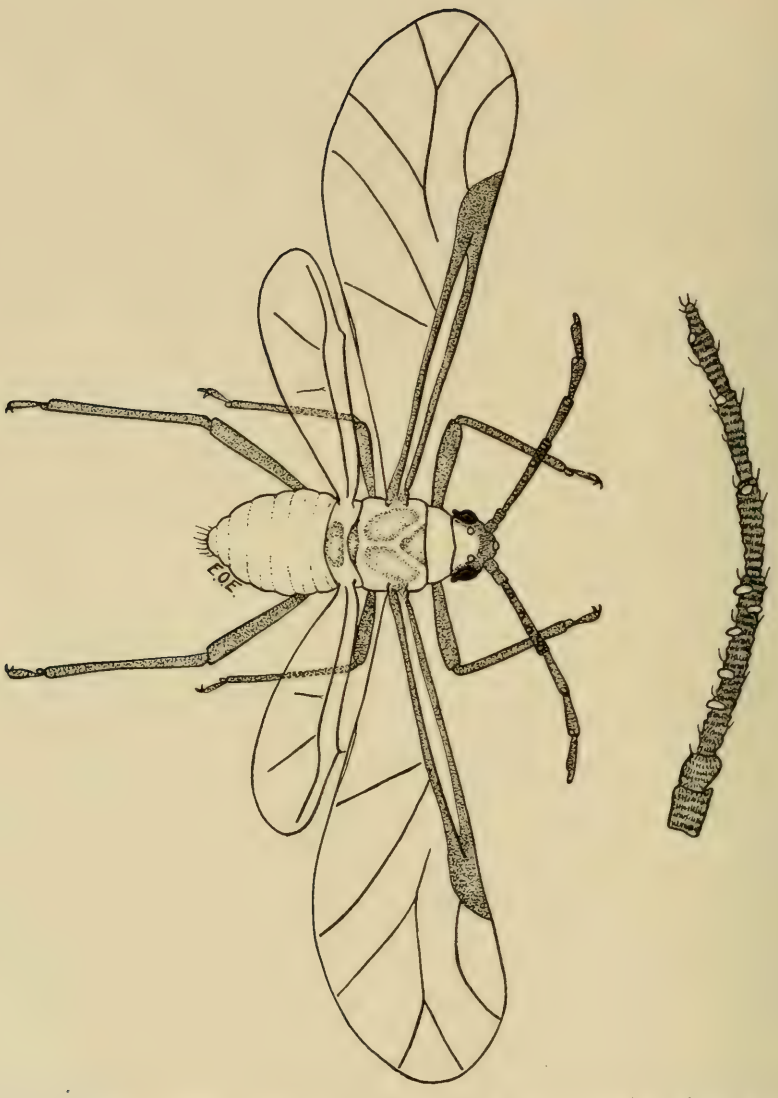


Fig. 7—*Phyllaphis coweni* (Cockerell). Male and a detail drawing of an antenna. (Original.)

it has been taken on the following: the common manzanita *(Arctostaphylos manzanita)*, the great-berried manzanita *(A. glauca)*, *A. tomentosa* and *A. pumilla.* The writer has never taken it upon the latter but Mr. Davidson has recorded it. Very characteristic galls are formed at the edges of the leaves. The greater portions or the entire leaves may thus be disfigured. The galls vary in color from that of the normal leaves to very bright red. Old galls eventually die and become black with age. The shape is shown in Fig. 4.

### Distribution

The distribution of this species is wide and apparently coincides with that of the various species of the food plants. It occurs in the Rocky, Sierra Nevada and Coast Range Mountains. The writer has taken it in many parts of the state, but it appears to be most abundant in the Sierra foothills and the Coast Range Mountains in the middle and northern parts of the state, though it is abundant in the southern parts as well.

### Date of Collection

The insect is probably most abundant in August in California. At that time all forms are present in the galls and all of the writer's specimens were taken then. However, the insect persists in some active form practically throughout the entire year. Serial No. 60.

### Natural Enemy

Chief among the insects which prey upon this aphid is an anthocorid bug. The bright red nymphs may often be found in practically every gall.

## THE CLOUDY-WINGED OAK APHIS

*Callipterus bellus* (Walsh)

(Figs. 8 and 9)

*Aphis bella* (Walsh)—Proc. Ent. Soc. Phil. I, p. 299, 1862.

*Callipterus bella* (Walsh)—Monell, Bul. U. S. Geol. Surv., p. 29, 1879.

*Callipterus walshii*—Monell, Bul. U. S. Geol. Surv., p. 29, 1879.

*Myzocallis bella* (Walsh)—Thomas, Rep. Ent. Ill., VIII, p. 106, 1880.

*Aphis bella* (Walsh)—Thomas, Rep. Ent. Ill., VIII, p. 107, 1880.

*Callipterus walshii* (Monell)—Thomas, Rep. Ent. Ill., VIII, p. 196, 1880.

*Callipterus bella* (Walsh)—Thomas, Rep. Ent. Ill., VIII, p. 197, 1880.

*Callipterus bella* (Walsh)—Monell, Can. Ent. XIV, p. 14, 1882.

*Callipterus walshii*—Monell, Can. Ent. XIV, p. 14, 1882.

*Callipterus bellus* (Walsh)—Œstlund, Aphid, Minn., p. 43, 1887.

*Callipterus bellus* (Walsh)—Osborn-Sirrine, Proc. Ia. Acad. Sci. 1, III, p. 99, 1893.

*Callipterus bellus* (Walsh)—Osborn-Sirrine, Insect Life V, p. 236, 1893.

*Callipterus bellus* (Walsh)—Hunter, Bul. 60, Ia. Agrcl. Exp. Sta., p. 89, 1901.

*Callipterus bellus* (Walsh)—Sanborn, Kan. Univ. Sci. Bul. III, p. 40, 1904.

*Callipterus bellus* (Walsh)—Davis, Jr. Ec. Ent. III, p. 417, 1910.

*Callipterus bellus* (Walsh)—Morrison, 5th Rep. Ent. Ind., p. 216, 1912.

*Callipterus bellus* (Walsh)—Davis, Bull. Ill. State Lab. Nat. Hist. III, p. 114, 1913.

This is a rather small, inconspicuous aphid which often occurs in great numbers on the undersides of the leaves of the coast live oak, *Quercus agrifolia,* in the southern part of the state. To the knowledge of the writer this species has never before been reported as occurring in California. It has only been collected by S. H. Essig, who first took it at Alhambra, Cal., Jan. 28, 1912, and later at Ventura, Cal., May 27, 1913. The specimens taken were only of the different stages of the winged viviparous female. No oppor-

tunity has been afforded to study the life history and to determine if other forms appear earlier or later in the season. Specimens were sent to Mr. John J. Davis, who verified the above determination.

### Winged Viviparous Female

(Fig. 8)

The adult winged viviparous females are bright or pale-yellow with dark markings on the body as indicated in the drawing. They are rather small, attaining a length of from 1.5 mm. to 2 mm. and a width one-third of the length. The head is slightly narrower than the prothorax, light-yellow with dark-red eyes. The antennæ are 6-articled and situated on slight frontal tubercles. Article I is usually the same color as the head; II, dusky-yellow; III, dusky or light-yellow; IV, yellow with dusky tip; V, yellow with the apical half dusky; VI, dusky. The lengths of the articles are as follows: I, 0.06 mm.; II, 0.05 mm.; III, 0.44 mm.; IV, 0.25 mm.; V, 0.23 mm.; VI, 0.34 mm.; total, 1.37 mm. The sensoria are circular and somewhat variable in number. There are usually 4 or 5 on III, though the number may vary from 4 to 7. They are usually confined to the basal half of the article. Article IV has none. Article V usually has one near the tip. Article VI has 2 or 3 in the process. The rostrum is very short reaching scarcely beyond the front coxæ, yellow with dark tip and very blunt. The prothorax is slightly wider than the head and about the same length, yellow with a prominent black vitta on each side extending to the full length directly behind the eyes. Each vitta is continued on the mesothorax to or slightly beyond the base of the front wing. The muscle lobes are not noticeably different in color from the rest of the thorax. The legs are the same color as the body with the following exceptions: the front tibiæ and tarsi are dusky, the tips of the middle tibiæ and tarsi and of the hind tibiæ and tarsi are also dusky. The abdomen is yellow with two prominent and one indistinct dark tubercle on the dorsum in line with and just in front of each cornicle. There are also red spots on the dorsum of some individuals. The cornicles are short, as wide at the base as the length, light-yellow

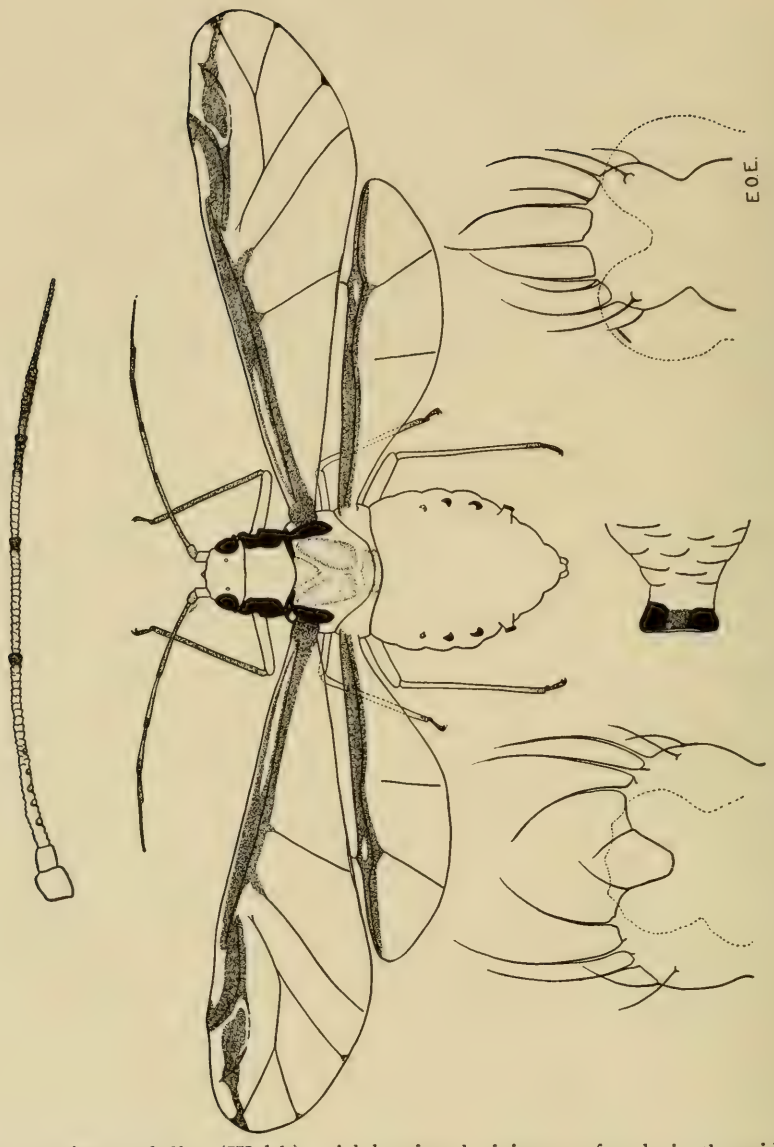


Fig. 8—*Callipterus bellus* (Walsh). Adult winged viviparous female in the middle with antenna at top, anal plate at left bottom, cornicle at middle bottom and cauda at right bottom. (Original.)

with dusky tips, 0.06 mm. long. The wings have a long narrow clouded area extending the full length along the front margins of both pairs as shown in the drawing. These markings are the most noticeable characteristic of the species. The venation is also shown in the drawing. The length of primary wings is about 2.6 mm. and the length of the secondary wings about 1.7 mm. The cauda is the color of the body or slightly dusky, distinctly knobbed and supporting several long hairs. The anal plate is distinctly bilobed and also hairy (Fig. 8).

## Nymphs

The nymphs of the winged viviparous females are very transparent, pale or bright yellow when very young. They are covered with very noticeably long, capitate, glandular hairs which persist until the last moult. The fully-developed nymph is bright-yellow with dark markings on the antennal articles and dark tubercles on the dorsum as shown in Fig. 9. The tubercles are located at the bases of the glandular hairs in somewhat definite rows—at least four rows of large tubercles are noticeable and two rows of smaller ones. Sometimes there is evidence of two more rows of small spines, making 4 rows of large tubercles and 4 rows of small tubercles in all. The eyes are red. The legs are pale-yellow with the tarsi of all and the bases and tips of the hind femora dusky. In some individuals the tips of all of the femora appear dusky.

## Food Plants

The food plants of this species seem to be limited to various kinds of oak trees. In the eastern states it has been taken on *Quercus rubra* by Monell[1] and Œstlund[2], on *Q. coccinea* by Hunter[3], on *Q. macrocarpa* by Thomas[4] and on white oak *(Q. alba ?)* by Morrison[5]. It has only been taken on the coast live oak *(Q. agrifolia)* in California.

[1] Monell, J. T., Bul. U. S. Geol. Surv. V, p. 29, 1879.
[2] Œstlund, O. W., Aphid. Minn., p. 43, 1887.
[3] Hunter, W. D., Bul. 60, Ia. Agrcl. Exp. Sta., p. 89, 1904.
[4] Davis, J. J., Bull. Ill. State Lab. Nat. Hist. III, p. 114, 1913.
[5] Morrison, H., 5th Rept. Ent. Ind., p. 216, 1912.

## Distribution

This species is apparently very common in the United States east of the Mississippi River. That it occurs in California would indicate that it also occurs in other localities west of the Mississippi River. As previously stated, it has been taken in two places in California, at Alhambra, Los Angeles County, and at Ventura, Ventura County.

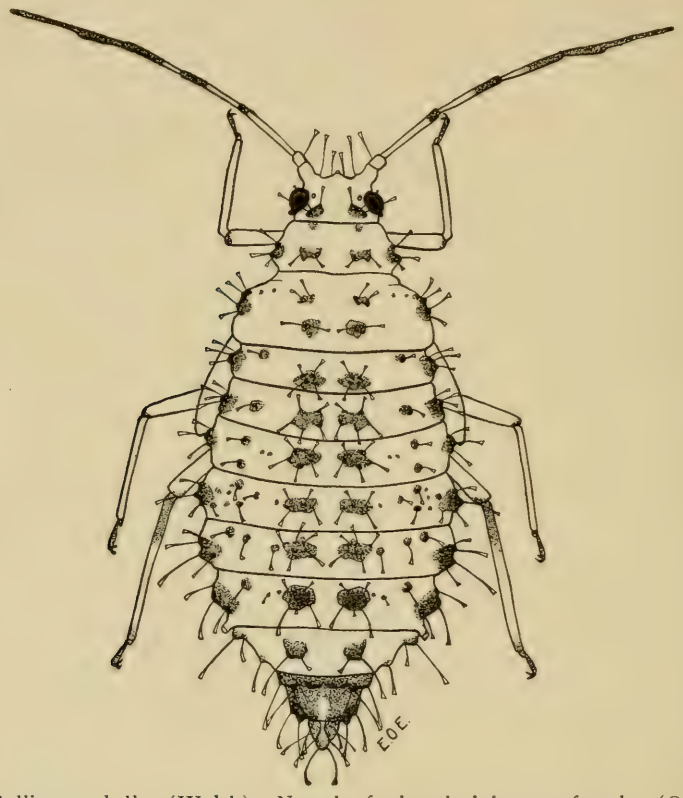


Fig. 9—*Callipterus bellus* (Walsh). Nymph of winged viviparous female. (Original.)

## Dates of Collection

The specimens in the collection were taken at Alhambra Jan. 28, 1912, and at Ventura, May 27, 1913, by S. H. Essig. Serial No. 59.

# Pycnogonids Collected During the Summer of 1915, at Laguna Beach

WILLIAM A. HILTON

While collecting embryological material from the littoral regions of Laguna Beach, some additional points in connection with the life history, habits and distribution of pycnogonids were brought to light.

In all over seven hundred specimens of various species were found, but a much larger number might have been obtained in certain cases because the localities where they live were so clearly determined.

Certain species were obtained with greater difficulty during the past summer, and some species seemed more abundant. All species found last summer, with the exception of *Phoxichilidium femoratum* Cole and *Nymphon* sp., were found again this year, while three or more species found this summer were not found last. In most cases the pycnogonids were found not far from hydroids, sea anemones or a certain coarse kind of polyzoan. The place which furnished the animals most abundantly was at Balboa Bay among the tubularian hydroids which occur in great masses. In this locality, first brought to my attention by Mr. F. W. Daniels, a hundred pycnogonids were found in one little clump of hydroids, while here and there in other masses they were nearly as abundant. The species found was one not seen last year. It was *Anoplodactylus erectus* Cole. Another species not clearly recognized last year was among *Phyllospadix* in certain localities. Two species found very often in this eel grass were *Ammothella spinosissima* Hall and *Anoplodactylus californicus* Hall. Now and then other forms were collected from these localities, but these two species were found over and over again in certain masses of this plant, especially if hydroids and Polyzoa were near at hand. Under a stone in one situation a large

number of hydroids were found and among and near them quite a number of *A. californicus* were obtained.

Three localities were mentioned last year in the littoral regions: (1) under stones, (2) among coarse polyzoan colonies and (3) out on mussel points among red sea weeds of various sorts. Three other general regions may now be added: (4) among hydroids especially large kinds, (5) among the stems and roots of Phyllospadix, (6) at the bases of sea anemones or near them. In every case except the last, hydroids or polyzoans may be near and aid in determining the occurrence, but in some few cases as under certain large stones, among seaweed and at times in Phyllospadix roots, the polyzoans or hydroids are not evident. The food and shelter of pcynogonids seem in large degree to depend upon these two groups of animals, but pycnogonids probably feed on any soft animal that comes near. Hall mentions one feeding on a nudibranch and I saw a *Palene* devouring a soft annelid worm, its claws and proboscis were stained with its dark juices.

In no case were pycnogonids found in unsheltered situations, they were not found among corallines, nor among certain other seaweeds where the water was swift. Some forms were well inshore, among these was *Ammothella bi-unguiculata* var. *californica* Hall, which was found one day especially abundant under stones well inshore. *A. spinosissima* was always found well inshore, a few under stones but chiefly among Phyllospadix roots. *Anoplodactylus californicus* was found well inshore. *Pycnogonum stearnsi* Ives was also found well inshore. The occurrence of the other species was for the most part farther out than these last mentioned forms.

A few points in connection with the reactions and general habits of these animals might be recorded. I have seen the swimming movements mentioned by Cole especially in *Palene, T. intermedium* to a less degree, as also in *H. viridintestinalis*. The other forms are too heavy to swim or tread water. All the species with long legs move much the same way in walking, alternate legs are moved at the same time as a rule, although now and then adjoining legs may be moved. In those with longer legs, these long appendages

are used as feelers, and one or several of them may be extended or elevated. In a dish of water the animals cannot walk very well, but partly walk and partly swim in some cases. The head end is not always the part which begins or determines the direction of the slow phalangid-like movements. When several specimens are left in a dish it is not long before all are in a ball, holding to each other by means of their sharp claws.

If two specimens are near they are soon drawn together. This clinging instinct is a very important one for the animals and is well developed. Those with long legs if kept separated fold at the third joint so that they look like little stools; they may fold either with the legs on the dorsal or ventral side. Some individuals seem to prefer one side, others fold the legs on either side equally readily. In some, especially those with eggs, the legs are folded in this way over the eggs. In some the legs may be folded closer to the body and the whole animal is like a little ball. In such a form the legs may be made to extend themselves if the animal is lifted and dropped a little distance. This will work every time with some but with a few, such as *A. spinosissima,* the legs become more tightly drawn to the body and the animal may even remain as though dead during several changes of its position. Many, if not most of the Pycnogonids can right themselves if turned over, but most of them rest as well on the back as on the ventral side. Righting movements are either by action of all legs at once from a stool position, or movements of only a few legs. *P. stearnsi* is somewhat an exception to many of the activities of the others mentioned. Its legs do not fold up much, they walk very little, do not swim and are in every way less active than the other species. They do cling to each other and if there are a number in a dish together they soon form a single ball. They cling to each other or to other objects, but from the shape of their legs and bodies they cannot hold very fast to anything.

The following is a list of the specimens obtained during the summer of 1915. At another time some further observations relating to the life history of at least one species may be given.

*Palene californiensis* Hall

Found almost entirely among the zooids of a certain coarse polyzoan. Seventeen specimens collected.

*Lecythorhynchus marginatus* Cole

No new information was obtained about this species. Found as last year among mussels, now and then in red seaweeds. They can walk quite rapidly through seaweeds. One hundred specimens were collected.

*Ammothella bi-unguiculata* var. *californica* Hall

Found among mussels to a limited degree, chiefly under stones at low tide. Fifteen specimens were collected.

*Ammothella spinosissima* Hall

Last year this species was found under stones only, but this summer most of them were found in the roots of *Phyllospadix*. This species is an inshore form. It is rather slow in its movements and depends upon its form and color to escape observation. The masses of sand caught in the long spines and hairs often help to conceal it. When much disturbed it may fold up and appear to be dead. Seven specimens were found.

*Ammothella spinifera* Cole

No specimens of this species were found last year. Two were found this summer among mussels out on the points.

*Ammothella tuberculata* Cole

Found as last year, among mussels and coarse polyzoans. Twenty-seven specimens.

*Tanystylum intermedium* Cole

A large number of these, one hundred and thirty-one in all, were found chiefly among polyzoan colonies; also under stones and among mussels to a limited degree.

*Tanystylum orbiculare* Wilson

Many of these, eighty-one in all, were found among mussels and older polyzoan stems.

*Clotenia occidentalis* Cole

Only one specimen found among mussels.

*Halosoma viridintestinalis* Cole

A number of these, ten in all, were found as last year among polyzoan masses.

*Anoplodactylus californicus* Hall

More of these were found than last year, chiefly among the roots of *Phyleospadix*. Those that were found abundantly under stones were near large hydroids. Thirteen specimens in all were collected.

*Anoplodactylus erectus* Cole

None of these were found last year, while between two and three hundred were found this season. All but one were taken from tubularian hydroids at Balboa. The one specimen from nearer Laguna was from an uncertain location and was a young specimen. The first lot obtained from Mr. Daniels contained a hundred specimens—immature and young adults, but no specimens with eggs. At a later time large numbers with eggs were obtained chiefly from the older stems of the hydroid masses. On the polyps and in them various stages of development were found. At a later time the life history of this species will be considered more in detail.

*Pycnogonum stearnsi* Ives

Last year only two specimens of this species were obtained. This year twenty-four were collected and many more might have been taken. No males with eggs were found, but in September a number of very young were obtained. Most of the specimens were found at the bases of medium-sized sea anemones; a few were found well inshore in seaweeds near sea anemones. They seem to be fairly abundant in some places. Often one large one was seen first and then under it one or two smaller specimens were found. When a number were placed in a dish they formed themselves into a compact ball. They are slow in their movements, and as they are inshore species it may be that they live better in the

laboratory than other species. The legs are capable of very little movement and they rest for long periods in a stationary position.

In addition to the above there were numerous embryonic and larval stages of various species and a number of immature and undetermined forms. Among the undetermined forms was a most interesting and peculiar adult specimen which may prove to be a new species, or at least quite a different type of pycnogonid. It will be described at a later time.

*(Contribution from the Zoological Laboratory of Pomona College)*

# Additional List of Annelids From Laguna Beach

W. F. HAMILTON

The following is a list of annelid worms determined from the collections of the summer of 1915. A number of others as yet undetermined may be added later.

*Eurythæ californica* Johnson

Found crawling along the under sides of stones at low tide.

*Halosydna pulchra* Johnson

Commensal on the holothurian *Stichopus californicus* (Stimpson).

*Phyllodoce medipapillata* Moore

Common in kelp holdfast from deep water.

*Nereis vexillosa* Grube

Found partly digested in the stomach of a baracuda, also on a holdfast.

*Lumbrinereis erecta* Moore

Abundant in the roots of *Phyllospadix.*

*Aracoda semimaculata* Moore

Very common under mussels on a flat near the laboratory.

*Nainereis longa* Moore

Common in *Phyllospadix.*

*Nainereis robusta*

Found in *Phyllospadix* roots, but not so commonly as the last species.

*Sabellaria cementarium* Moore

A single specimen was found in a holdfast.

*(Contribution from the Zoological Laboratory of Pomona College)*

# Three Common Spiders of Laguna

Margaret L. Moles

Plate I. *Argiope argentata* Fabricus. Female.

*A. argentata* was collected abundantly on the sage-brush and cactus. The webs are very large, irregular orbs. The position taken by the spider when on the web is very characteristic. The spider hangs in the center of the web, its forelegs straight beside the head, the hind legs horizontal with the cephalothorax. Colonies of these spiders were found in the center of a clump of cactus. In one small clump there were found five (5) adults on webs and numberless small ones with webs started or partially completed. *A. argentata* is very quick in its movements and drops to the ground as soon as touched.

Individuals differ in the markings of the abdomen. The differences seem to be mainly in the amount of black coloring on the lower part of the abdomen. In some specimens the silvery white color being everywhere except on the tips of the last three (3) tubercles and the black folium.

This species has been collected also in Claremont, but not so abundantly.

Plate II. *Tetragnatha laboriosa* Hentz. Female.

This little spider was found on everything and everywhere. It was especially on tar weed, but also inhabited honeysuckle, grass and all the other flowering plants of the dry hills and mesas around the beach. There were very few differences among the different individuals as to markings or colors, though in some the folium on the abdomen was darker than in others, and the shades of yellow on the legs and cephalothorax varied slightly. The spider did not spin a web to live in nor to help in catching food, but depended upon its own speed to gather in flies and insects. This species was by far the most common of all the spiders collected at Laguna. It has also been collected in Claremont, but only a few times.

Plate III. *Gasteracantha maura* McCook. Female.

This species was collected on sage brush which grew on the hills and bluffs at Laguna Beach. The web was a small orb and spun right near the top of the bushes. Collectors could not fail to see these small spots of bright color hanging as it seemed in midair among the bushes.

The specimens collected differed in color and color pattern. The color on the abdomen varied from dark orange to light lemon yellow. The black spots on the upper edge of the abdomen and on the lower tubercle are sometimes fused together, the ones on the upper edge making an irregular line, while those on the tubercle make a large, irregular spot. This species was fairly common and abundantly collected in July. It has been collected in Claremont also, but not so abundantly.

*(Contribution from the Zoological Laboratory of Pomona College)*

Plate I. *Argiope argentata* Fab

Plate II. *Tetragnatha laboriosa* Hentz

Plate III. *Gasteracantha maura* Mc Cook

# The Early Development of Ligyda with Reference to the Nervous System

William A. Hilton

The material for this study was obtained at Laguna Beach during the summer of 1913. This species of isopod, *Ligyda occidentalis* Dana, is very abundant on the rocks, and it was an easy matter to secure females carrying the eggs or young, and any stage could be easily obtained even late in the summer. With the fresh specimens one of the most valuable methods for preliminary observation was to examine the embryos after fixation, but before dissection or staining or even changing to an alcoholic fluid. The use of Gilson's fluid for this purpose made it possible to detect at once the general features of the embryo even in early stages. This reagent whitened all parts of the embryo and they could be seen as opaque white on the yellowish yolk. Figures 1 to 21 were drawn from embryos treated in this way. The disadvantages of study by this method alone are: First, it is rather hard to tell the meaning of certain parts which show, and, second, cell outlines are not clear except in very early stages. Embryos fixed in this and other ways were removed from the yolk, stained and mounted as a whole, or cut in serial sections.

In the early development of the embryo there is a gradual concentration of cells at one pole of the egg. From Gilson's preparations it was learned that at a very early stage the general area of the optic lobes was outlined, as shown in Figs. 1, 2, 3, and 4. A white spot at the center of the area, later at the caudal end, indicates a thickening of cells which may be in the region of invagination. Gradually thickenings back of the optic area begin to indicate the position of the appendages; two of these are shown in Fig. 3, and a larger number in Figs. 4 and 5. These first thickenings are so faint and so variable in early stages that I cannot place much value upon them. It seems probable, however, that the three marked areas in the cephalic region of Fig. 5, represent the three naupliar appendages recognized by Nusbaum and others. In Fig.

6 the naupliar appendages are better marked and may be considered to be the three large paired areas below the optic lobes. In Figs. 10 and 11, the brain region is outlined; there are also in these stages indications of the various ganglia more or less opposite their appendages. In Fig. 8, many appendages are evident, and there are many more segments than in earlier stages. At this time the segments are similar, the brain and optic lobes show and the mouth area is seen. Fig. 9 shows a typical pair of body ganglia of a slightly earlier stage. At such a stage the ganglia seem made of two pairs. In Fig. 10, the naupliar appendages have changed positions and there is a long series of closely applied appendages similar to those in Fig. 8. Figs. 12 and 13 show considerable shifts in the upper appendages. The lack of harmony between the results of McMurrich and these may be easily explained. The adult isopod has the following appendages: (1) Antennules, (2) antennæ, (3) mandibles, (4) first and second pairs of maxillæ, (5) one pair of maxillipeds, (6) seven thoracic legs, (7) six abdominal appendages. The appendages, as already shown, are first developed in the head region and then added to from the caudal end. At a time of a maximum number of appendages and segments the appendages are much alike, but there are differences in size, and at a later time there are changes in position. In the region of the third and fourth appendages there is a great crowding, so that segments may be fused and appendages covered. This is shown to some degree in Figs. 12, 13, 14, and 15. McMurrich failed to recognize this, and he apparently counted in the first thoracic leg as a maxilliped. The biramous structure of Figs. 12 to 15 is really the first thoracic leg, as is clearly shown in Fig. 13. Other legs of these stages may be seen to be biramous when separated from each other, but this first thoracic leg seems to retain this condition longest and remains small for a long period.

McMurrich failed to call this a leg, and yet had the right number of legs! This probably came about through another slight oversight. At one period preceding Fig. 13 each segment has an appendage, but after a time the last thoracic or first abdominal segment, whichever it is, loses its appendage. This is the segment which seems to have been counted in by McMurrich to bring up the right number of legs.

Each segment of the body has its ganglion at an early time. This segment between thorax and abdomen which loses its appendage has a well developed ganglionic group or mass.

As the optic lobes and brain grow in size, they come to take up a more dorsal position, as seen in the figures. After a time pigment begins to be evident in the lower edge of the eye, as shown in Figs. 22 and 23. When the embryo or young has its eye fully pigmented, the little animal is much like the adult.

The preceding outline of development so far given presents the method of development of the embryo as a whole as well as the gradual increase in size of the ganglia, optic lobes and brain. The development of the cells which take part in this formation of the appendages and nervous system is better shown in whole mounts or sections.

McMurrich, Nusbaum and others show clearly the development of the post-naupliar region of isopods from teloblastic growth. I have very little to add to their complete accounts. Fig. 24 shows a surface view of an unstained egg in which is a half circle of teloblast cells near the center of the early cell area. Fig. 26 shows a later stage of an embryo. The teloblast cells which form the ectoderm are much enlarged and the six middle rows indicate the cells which develop the nervous system. Fig. 25 is from the nervous system of a similar early stage; the lower appendages and the nervous area between are of teloblastic formation, while the cephalic broader portion of the embryo was probably chiefly formed from sells in situ. In Fig. 27 the teloblasts are still adding material at the caudal end of the embryo. Several ganglionic areas are more or less distinct. Sections of stages similar to this show little differentiation between cells of the general surface and the nervous system. In later stages the ectodermal cells multiply to form the ganglia, and the thin line of surface ectoderm becomes separated and splits off.

With the growth of the embryo the cells of the brain and ganglia become marked off from the other cells. A ganglionic area from each of the appendages in the head region is evident, and in addition some cell groups which seem separate, as for instance one near the first antennal ganglion. Into the brain are fused the optic

and first and second antennal ganglia, as well as the more central part of the brain, which is made up of several parts. Into the subesophageal ganglion are fused the lateral parts of the mandibular, two pairs of maxillæ and the pair of maxillipeds. Into the thoracic ganglia there seem to be fused two lateral pairs of ganglia for each segment. In the abdominal region the ganglia are not so clearly made out at all stages. Each ganglion is composed of two lateral halves. There are at one time probably a large number of segments much alike as to their ganglia. The abdominal ganglia become massed closer and closer together and fuse into practically one mass.

McMurrich speaks of an extra appendage without a ganglion in the head region of isopod embryos, about opposite the mandibles. I am not sure but this is the appendage which has been crowded up from below, yet I have found an extra appendage in about this region in certain stages. A number of investigators also speak of an extra ganglion near the brain and separate from the one of the first antenna. I have seen this in a number of stages. It seems like a center of cell growth much like several others.

In Figs. 28, 29, and 31, three different stages in the development of the brain and optic lobes are shown. Whatever the different cell groups may mean, it is possible to trace the development of the areas from one stage to another. Three main parts of each lateral brain and optic lobe region develop quite early. This is due in part to the different directions of cell growth and also to the different rates of growth in different areas. Figs. 30 and 32 are different stages in the development of ganglia viewed from the ventral side. Figs. 31 and 33 are from the same specimen of a rather advanced stage, such a stage as shown in Fig. 14.

The gradual development of the shape of the ganglia, their differentiation from the ectoderm of the surface and the development of the fibrous portions are shown in the drawings of sections of Figs. 33 to 49. The thoracic and abdominal ganglia of a stage such as 11, is shown in cross-section in Figs. 33 and 34. Fig. 35 is a longitudinal section through the ganglion in the middle line of a similar stage. Figs. 48 and 49 are longitudinal and cross-sections through ganglia of stage 13 or 14, ventral side up, areas of

nerve fibers showing clear. Fig. 47 is a section through one side of the optic lobe and brain of the same stage, fiber area clear, cephalic side up. Figs. 36 to 39 are cross sections through ventral ganglia of an embryo 2.5 mm. long, ventral side up. Fig. 40 and Fig. 41 are through one-half of the brain and optic lobes of the last stage; the cephalic side is up. Fig. 42 shows the general arrangement of the brain and head ganglia, as shown in a median longitudinal section, the dorsal side is up. Fig. 43, is a longitudinal section of the abdominal ganglion of a 2.5 mm. embryo; the dorsal side is up. Figs. 44, 45 and 46 are from an embryo of 3.5 mm. length; 45 shows a section of one-half of the brain, cephalic side up, 44 and 46 are sections of the abdominal ganglion, frontal sections, cephalic end up.

At another time it may possible to follow the development of the histological elements of the central nervous system in more detail. What is given now is a mere outline, and does not take up the history of individual cells or cell groups as far as may be possible when the structure of the adult nervous system is carefully studied. In this paper there has been no attempt to follow the developments which do not relate to the central nervous system. A general summary of the development of the brain and ganglia is given as follows:

1. At a very early period the outline of the optic area may be recognized, although the cells which form the brain and optic lobes may not be the ones which give rise to this appearance. Such indications of this area are shown in Figs. 1, 2, 3, and 4.

2. The cephalic portion of the nervous system is then first indicated, the brain and optic lobes and the region of the three naupliar appendages being formed more or less *in situ* from ectodermal cells.

3. The meta-naupliar region of the embryo is formed from regular rows of teloblast cells, such as may first be recognized in a stage like Fig. 24. The ectoderm from these teloblast cells forms the covering for all the lower region of the embryo and along the middle line gives rise to the cells which form the central ganglia, as shown in Fig. 26. At such a period, when the location of the nervous area is possible, six or seven rows of cells in the central region may be considered to cover the nerve ganglion area.

4. The optic lobe and brain area become better and better marked. On each side of the middle line there are three chief areas developed.

5. Ganglia make themselves evident for each of the appendages of the head region below the eyes. There is a crowding together in this region and fusion of the ganglia. The first and second antennæ have their ganglia soon fused with the supra-œsophageal mass. There is in addition to these and the ocular masses an extra ganglionic area which fuses also, but no appendage is evident in connection with it. There are also other centers in the cerebral mass which may simply be centers of cell growth, as indeed this little ganglion may be.

6. The lateral ganglia of the other head appendages fuse into the subœsophageal mass.

7. The ganglia of the body are gradually added to from the teloblastic region at the caudal end of the body. At first the body ganglia are only slightly marked off from the surrounding ectoderm. These early formed ganglia are much alike in early stages, and each has its appendage. At a time of a maximum number of body segments, such as stages a little later than Fig. 8, there is no difference in the ganglia at different segments, except that the more caudal ones are a little smaller and less evident.

8. At an early period the ganglia of all appendages are made up of at least two lateral parts. Some of the ganglia in the thoracic region seem also to be made up of two parts each on each side.

9. When the ganglia are first formed there is little demarcation between them and they are not separate from the skin ectoderm. Later the skin ectoderm forms a distinct layer on the ventral side, as shown in Figs. 33 and 34.

10. In the body ganglia the nerve fibres begin to make themselves evident on the dorsal side as shown in Figs. 48 and 49.

11. In the brain, the fibers from the cells are first evident in central areas, as in Fig. 47.

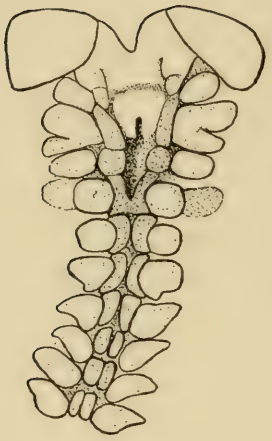
12. The ganglia of the abdominal region become fused into one mass when the young are from 3 to 3½ mm. in length, as shown in Fig. 46.

13. The cells in the body ganglia are not at all periods closely massed. It is possible to determine three main cell masses on each side in certain stages, as well as some smaller unpaired areas, as shown in Fig. 32.

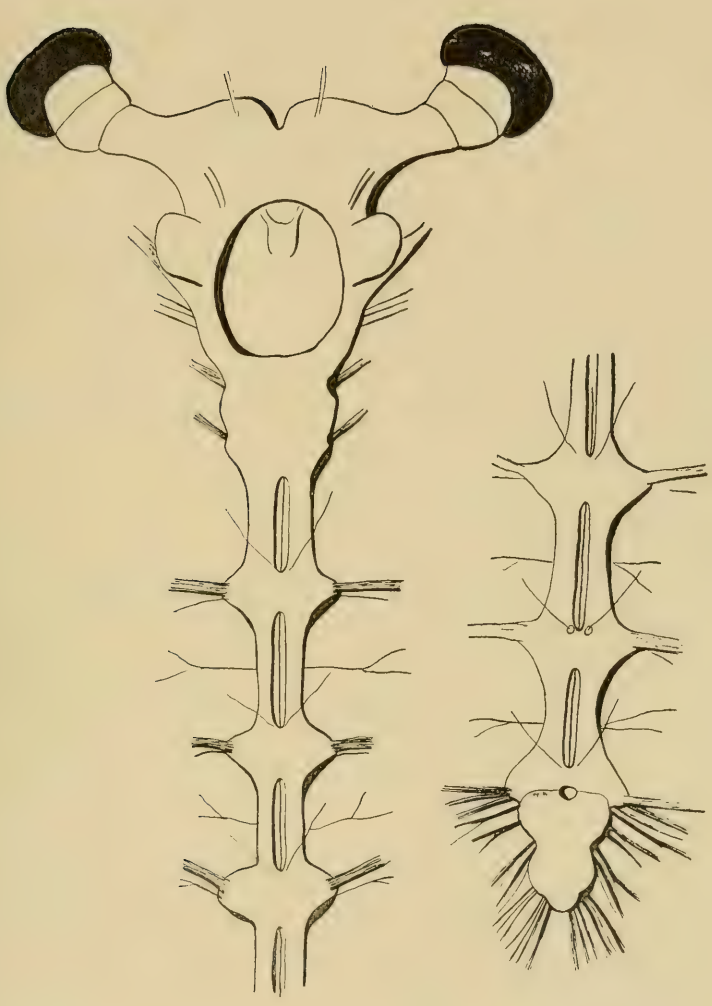
14. In the brain ganglion of an early stage it is possible to distinguish three main areas, counting the optic lobes and the eyes. In the central of these three, on each side there is the ganglion of the first antenna, and in addition four or more other marked areas whose meaning is not yet determined. The more lateral parts of the ganglion and optic lobe area have a large number of centers, as shown in Fig. 31.

15. At first the cells of the brain are much the same size, but in stages when pigment begins to show in the eyes, small cell areas may be found, as in Figs. 40, 41, and 45.

16. At a time when the whole eye of the young is pigmented, the brain and ganglia are much as in the adult, and fiber tracts are evident. It is at such a time that the animal is able to move about and run away; it is now from 3 to 4½ mm. in length.



TEXT FIGURE 1.—Sketch of the head end of an embryo of *Ligyda,* showing the ganglia opposite the appendages. Camera lucida sketch from a mounted preparation. ×70.



TEXT FIGURE 2.—Outline sketch of the central nervous system of *Ligyda*. ×9.

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*(Contribution from the Zoological Laboratory of Pomona College)*

## EXPLANATION OF FIGURES. DEVELOPMENT OF LIGYDA.

Figures 1-23. Sketches of embryos or parts at various stages. Mostly taken from freshly killed specimens. Figs. 1 to 8, 11-23, ×50; Fig. 9, ×300; Fig. 10, ×100.

Figure 16. Side view of stage like 6 or 7. Fig. 17. Side of 8.

Figure 18 of 11 or 12. Fig. 19 of 13. Fig. 20 of 14. Fig. 21 of 15.

Figure 24. Sketch of an early stage of preserved egg. The cells are indicated as they show on the surface of the yolk. Near the center is a half ring of teloblast cells.

Figure 26. Lower end of an early embryo, showing teloblast cell areas. The six central cell rows are those which go to form the nervous system in part. ×700.

Figure 25. Whole mount of an early embryo. The appendages begin to show. ×70.

Figure 27. Later stage surface mount. ×70.

Figure 28. Surface preparation of one-half the optic lobe and brain region of an embryo such as shown in Fig. 6. The dorsal side is at the top. ×460.

Figure 29. Surface view of one-half of brain and optic lobe region of an embryo like Fig. 8. ×460.

Figure 30. Surface view of body ganglion of embryo like Fig. 8. ×460.

Figure 31. Optic lobes and brain one side, embryo such as Figs. 12 or 13. ×700.

Figure 32. Thoracic ganglion from above, from embryo 12 or 13. ×460.

Figures 33 to 49. Sections of ganglia of various stages. All ×70. Ventral side up in 33 to 39, 48 and 49. Cephalic side up in 40, 41, 44, 45, 46, 47.

Figures 33 and 34. Cross section of body ganglia of 11.

Figure 35. Median longitudinal section of ganglia of 11.

Figures 36 to 39. Cross sections of body ganglia of a 2.5 mm. embryo.

Figures 40 and 41. Sections of one-half brain of a 2.5 mm. embryo.

Figure 42. Longitudinal section cephalic ganglia of a 2.5 mm. embryo.

Figure 43. Longitudinal section abdominal ganglia of a 2.5 mm. embryo.

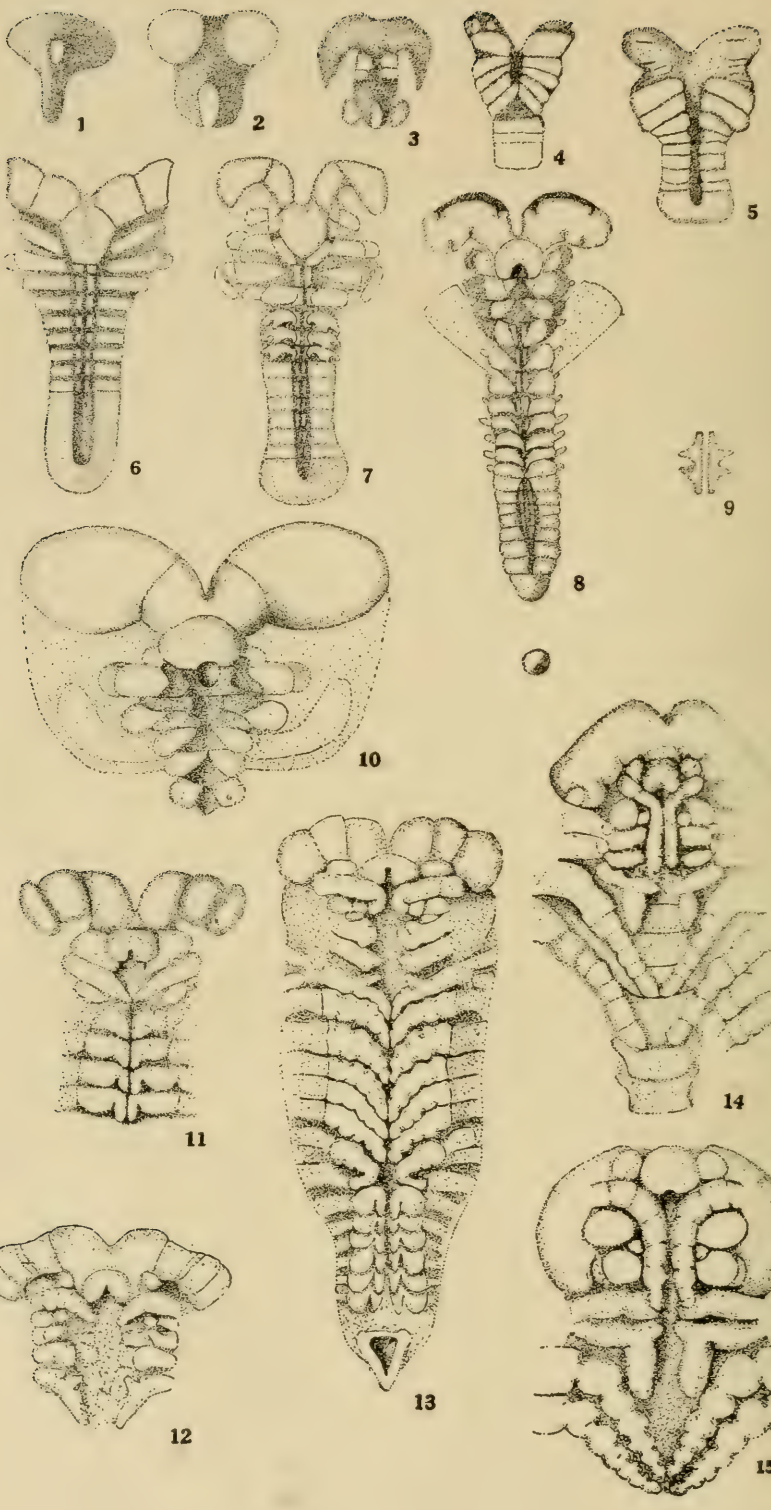
Figures 44 and 46. Longitudinal sections at different levels of the abdominal ganglion of a 3.5 mm. embryo.

Figure 45. Frontal longitudinal section of one-half the brain of a 3.5 mm. embryo.

Figure 47. Section of one-half a brain of an embryo about the stage of Fig. 15.

Figure 48. Longitudinal section of abdominal ganglia of the last.

Figure 49. Cross section, body glanglion of the last.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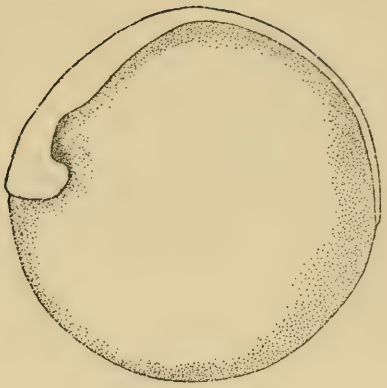

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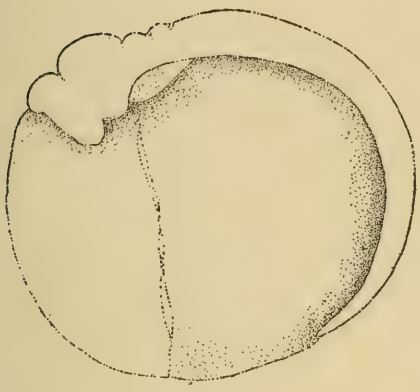

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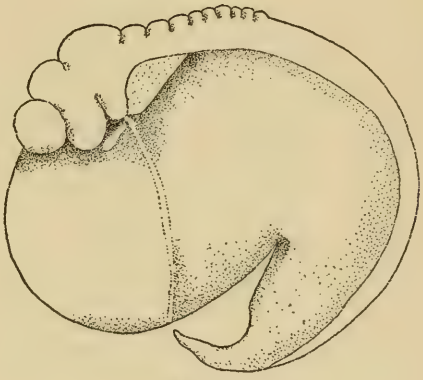

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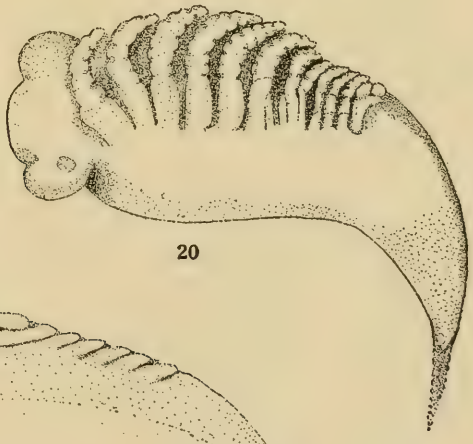

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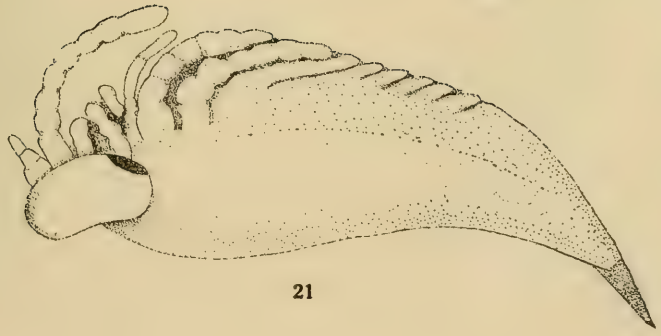

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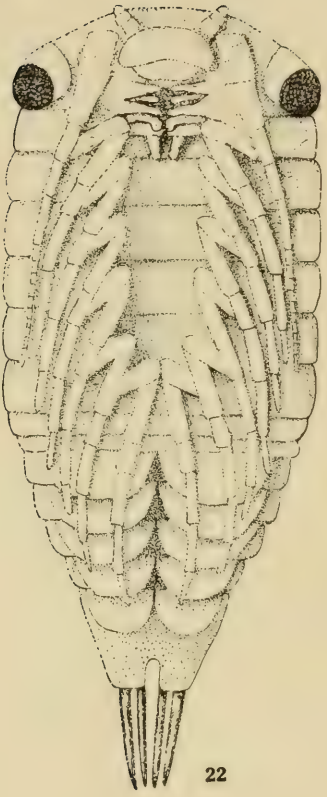

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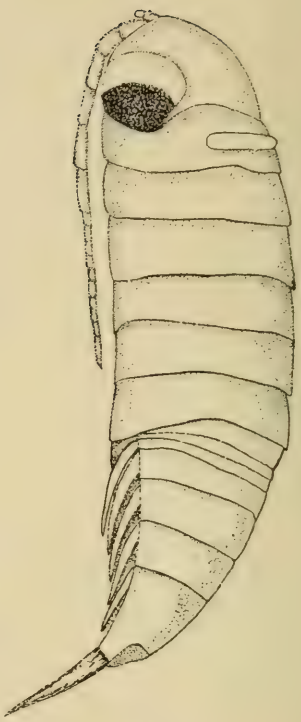

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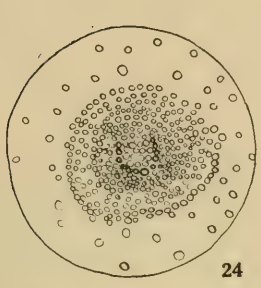

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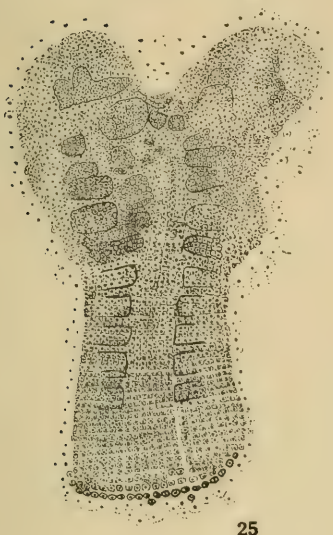

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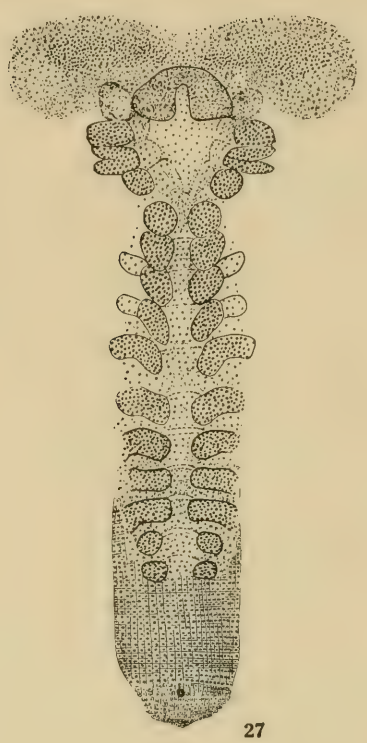

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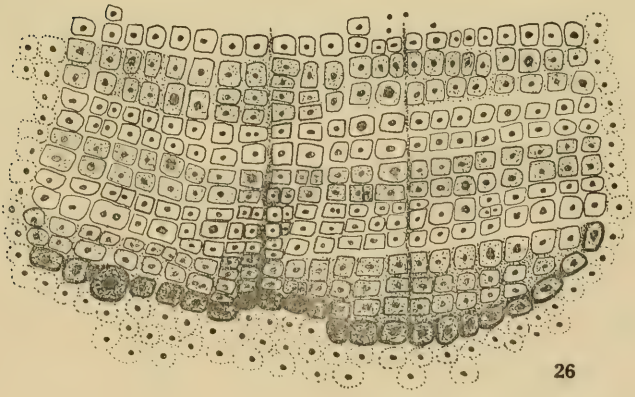

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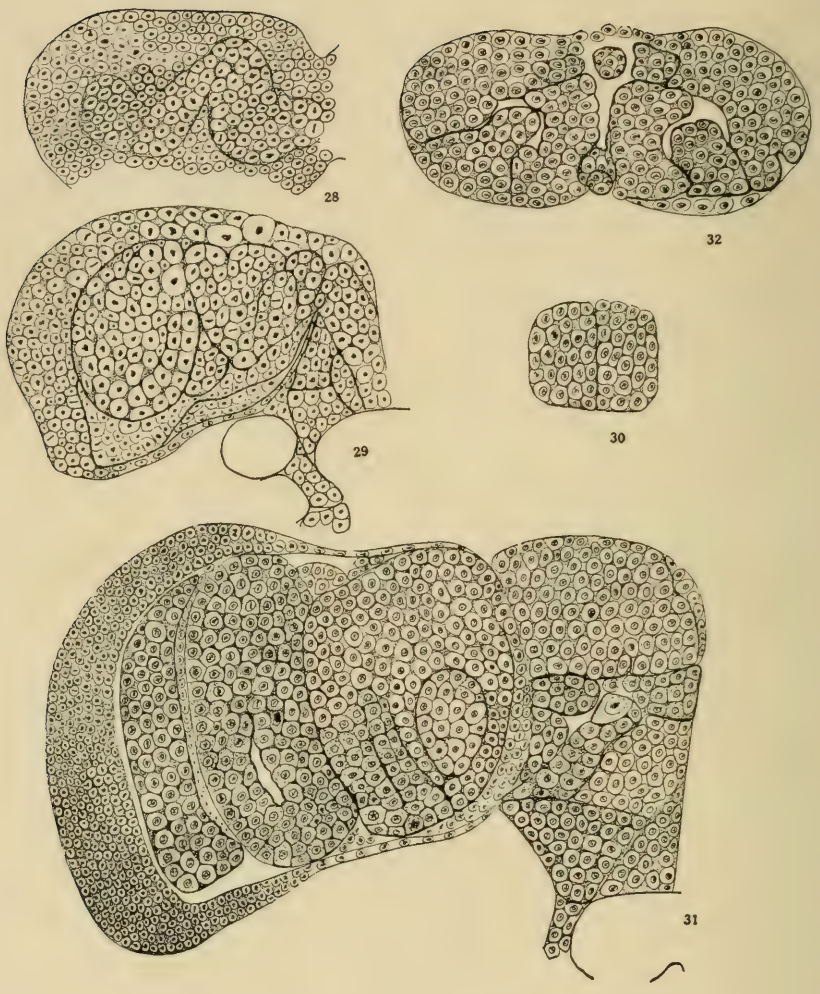
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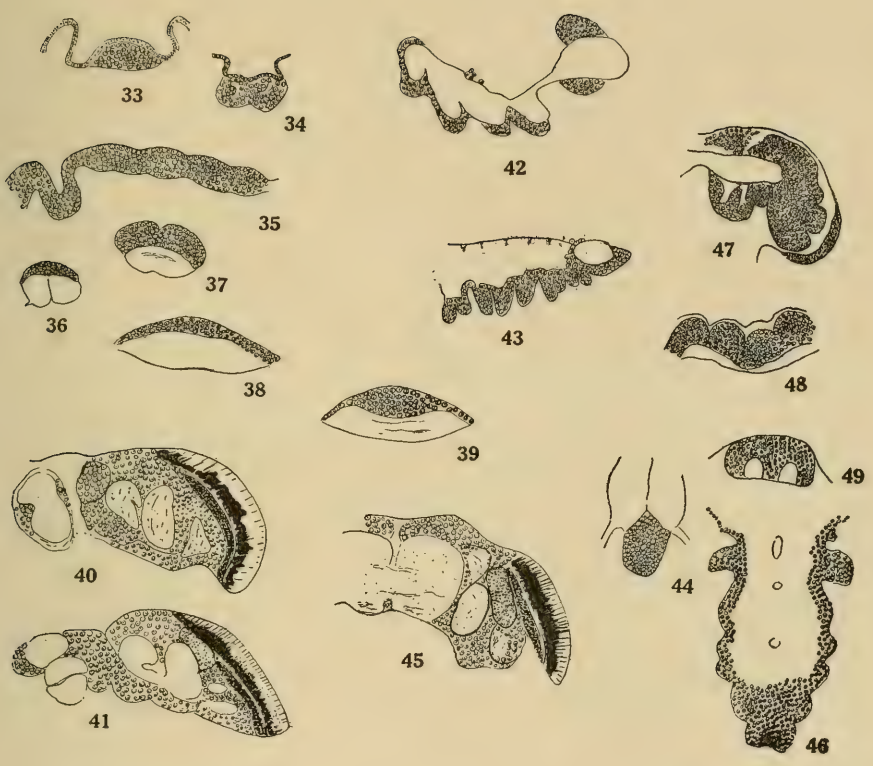
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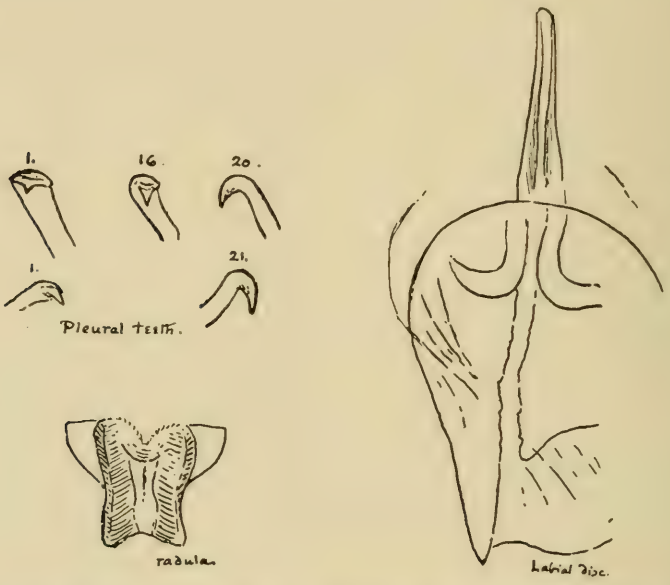
# The Nudibranch-Genus Triopha in California

By T. D. A. Cockerell

The genus *Triopha,* named by Bergh in 1880, includes a series of nudibranchiate molluscs occurring on the Pacific Coast of North America. On August 23, 1915, a new species of this genus was obtained by the Scripps Institution in shallow water off La Jolla, California, the particular lot of material containing it being listed as "haul 74." It may be known as *Triopha scrippsiana* n.sp., with the following characters:




Length about 27 mm.; white, marked with bright vermilion, like *T. carpenteri;* but tentacles pale yellowish olivaceous, not at all red; appendages of frontal margin (six on each side, one or more very small), small, the larger ones tuberculate, and all wholly white; small tubercles on body very bright vermilion, but they are mere subpyramidal eminences, not elongated structures as in *carpenteri.* Branchiæ very slightly marked with red, tip of tail red. (Described from living specimen.)

The distinctness of the species is confirmed by the radula, which has the teeth in about 58 rows, the formula for 29th row being 16-22-2-2-22-16. The inner 2-2 represents the rhachidian plates, which are very different from those of *T. carpenteri,* the inner ones being strap-like, very greatly transversely elongated, while the outer are also elongated. The form of the pleural teeth and uncini is about as in *carpenteri,* but the pleural teeth are more numerous. The labial disc is characteristic of the genus.


The Californian species of *Triopha* may be separated thus. It is doubtless correct to refer Cooper's *Triopa catalinæ* to this genus.

Body with light spots on a dark ground..... 1
Body without light spots..... 3

1. Frontal appendages 14; ground color, yellowish; processes vermilion. *catalinæ* (Cooper).
   Frontal appendages 12 or fewer; ground color brown, often dark ..... 2
2. Branchial plumes bright red. *maculata* McFarland.
   Branchial plumes white, the tips more or less red. *grandis* McFarland.
3. Body yellowish brown, processes tipped with vermilion; pleural teeth on each side, 7 or 8 in a row. *grandis* McFarland variety.
   Body orange, processes tipped with vermilion; pleural teeth on each side, 4 in a row. *aurantiaca* Cockerell.
   Body white, with the processes vermilion; pleural teeth on each side, 9 or more in a row..... 4
4. Rhinophores red; frontal appendages red. *carpenteri* (Stearns).
   Rhinophores yellowish olivaceous; frontal appendages white. *scrippsiana* Cockerell.

# New Californian Bees

By T. D. A. Cockerell

In a small collection of bees recently received from Pomona College, I find four new species, which are described herewith.

*Tetralonia pomonæ* sp. n.

♂ Length 10 mm., black with the clypeus pale lemon yellow, notched at sides; labrum pale yellow, but mandibles entirely black; antennæ black, flagellum reaching end of second abdominal segment; third antennal joint a little longer than broad; eyes (dry) very dark brown; face broad, covered with long dull white hair; thorax above with very pale ochreous hair; disc of mesothorax brilliantly shining, feebly and sparsely punctured; tegulæ fuscous with a rufous spot posteriorly; wings dusky hyaline; nervures rufopiceous; second s. m. narrowed above, receiving first r. n. a little beyond beginning of last third; legs with dull white hair, orange-ferruginous on inner side of tarsi; small joints of tarsi clear ferruginous, but basitarsi at most obscurely reddened apically; hind spur normal; abdomen with hind margins of segments narrowly hyaline; first segment with long pale hair; second with thin pale hair basally, but short fuscous hair subapically; third like second, but with a definite basal band of dull white tomentum; fourth covered with dull white tomentum, but a little fuscous hair just before margin; fifth like fourth, except that hind margin has a dense white fringe, and no fuscous; apical plate ferruginous, with fulvous hair on each side.

*Hab.*—Laguna, California (*R. La Follette*, B 2). In my tables in Trans. Amer. Ent. Soc., 1906, this runs to *T. lepida,* but it has not the narrow face of that species. It resembles *T. birkmanniella* Ckll. and *T. poetica* Ckll., but the three are easily separated thus:

Flagellum about 12 mm. long, reaching beyond end of third abdominal segment; upper margin of clypeus broadly black. *poetica* Ckll.

Flagellum 10 mm. or less; upper margin of clypeus not black. 1.

1. Second s. m. a little broader above than below; apical plate of abdomen broad at end; hair on outer side of hind basitarsi scanty and rather short. *birkmanniella* Ckll.

   Second s. m. narrower above; apical plate of abdomen narrow at end; hair on outer side of hind basitarsi abundant and long. *pomonæ* Ckll.

*Diadasia crassicauda* sp. n.

♂ Length about 10 mm.; black, with abundant though not very dense grayish-white hair; eyes narrow, grayish-green; face broad; clypeus shining, with fine punctures; flagellum entirely black; mesothorax shining, with small punctures very sparse on disc posteriorly; area of metathorax microscopically sculptured, with an opaque median sulcus; tegulæ reddish brown, blackened anteriorly; wings hyaline, slightly reddish; legs black, with long white hair, small joints of tarsi obscurely reddish; hind basitarsi gently curved, but not produced at end; first two abdominal segments with long loose pale hair, the others with appressed hair, and segments 2 to 6 with narrow white marginal bands; apex of abdomen bilobate, the lobes large and blunt, covered with very pale ochraceous hair except at the ends, which appear black; stipites with long red hair on posterior margin.

*Hab.*—Laguna, California (*R. La Follette,* B 7). Allied to *D. sphæralcearum* Ckll., but larger, with very much broader lobes at end of abdomen, those of *sphæralcearum* being spine-like. It does not seem probable that this is the male of *D. albovestita* Provancher.

*Exomalopsis nitens* sp. n.

♀ Length about or nearly 7 mm.; robust, black, mandibles dark red in middle, flagellum ferruginous beneath except at base; hair of head and thorax rather long, dull white, pale ochraceous dorsally; head and thorax shining, finely punctured; tegulæ piceous; wings grayish hyaline, nervures dark, stigma sepia; legs black, with small joints of tarsi ferruginous; scopa of hind legs large and beautifully plumose, dull whitish on tibia, gray (variably dark) on tarsi; first abdominal segment shining, the basal declivity bounded above by a distinct rim, the hind margin at each side with a broad, dense

white hair-band, wholly absent from the middle half; segments 2 to 4 with very broad entire bands of grayish-white tomentum; apex of abdomen with ochreous hair.

*Hab.*—Laguna, California (*R. La Follette,* B 5, B 8). In Friese's table of *Exomalopsis* (1899) this runs to *E. texana* Friese, but that is a much smaller species, with quite differently colored tegulæ and stigma. *E. texana* belongs to the genus or subgenus *Anthophorula* and *E. nitens* is doubtless to be referred to the same group, although the male is unknown. It is quite distinct from *A. coquilletti* (Ashm.), which Baker has taken at Claremont.

*Augochlora pomoniella* sp. n.

♀ Length about 8 mm.; bright emerald green, face tinted with golden, mesothorax bluer green, abdomen yellowish-green; clypeus strongly punctured, broadly black apically; mandibles with a small green spot at base; face very broad, eyes deeply emarginate (about as in *A. pura,* much more so than in *A. confusa*); front extremely finely and densely punctured; anterior lateral corners of prothorax rounded; tubercles prominent; mesothorax very finely and densely punctured; area of metathorax with many fine short plicæ, but the margin thickened, obtuse, without definite sculpture; tegulæ piceous, pallid anteriorly; wings dusky hyaline, nervures fuscous, stigma very dull ferruginous; first r. n. meeting second t. c. or entering extreme base of third s. m.; hair of head and thorax above scanty, dull white; femora largely green, tibiæ and tarsi black, anterior tibiæ with metallic tints in front; hind spur of hind tibia appearing simple under a lens, but the margin actually with about 20 little nodules; abdomen shining, very finely punctured, the first two segments with a hardly noticeable dark margin; fifth segment dark blue-green, with fuscous hair; venter black.

*Hab.*—Aliso Canyon, California (*R. La Follette,* B 15). A species of the group of *A. pura* and *A. confusa.* From *A. pura (robertsoni)* it is known by the much smoother, more finely punctured supraclypeal area, the thick rounded rim of area of metathorax and the dark nervures. From *A. confusa* it is known by the deeply emarginate eyes, broad face, much shorter plicæ of metathorax and dark nervures. From *A. neglectula* by the much broader head,

smooth and brilliantly shining posterior truncation of metathorax, etc.

At the same locality Mr. La Follette took *Agapostemon radiatus* Say (B 16) and *Halictus farinosus* Smith (B 1, B 11); the latter also at Laguna (B 3). Aliso Canyon is about two miles from Laguna Beach.

The specific name chosen, connecting the species with Pomona College, should in strictness be written *pomonæella,* but the derivation is ultimately from pomum, and it seems permissible to choose the less cumbersome form.

# On Two New Polynoids From Laguna

W. F. Hamilton

*Halosydna succiniseta,* n. sp.

Form attentuated posteriorly, like *H. lordi,* which form this closely resembles. Greatest width about somite 12, whence it tapers gradually to the slender hind end.

*Proboscis* (Fig. 3) large and strong. It is 4 mm. long and 2.7 mm. wide, cylindroid and slightly flattened distally. Papillæ, 9/9, irregularly conical. Jaws of clear yellowish chitin with large, sharp fangs of dark brown chitin, the lower biting to the right. There is a prominent tubercle, .5 mm., from the ends of each series of papillæ, and an irregular fold of cuticle surrounding the proboscis near the middle.

*The prostomium* (Fig. 3), decidedly wider than long, is full and rounded, either cheek being almost spherical. Eyes four, the anterior pair are a little larger than, and twice as far apart as the posterior. The tentacle, inserted about one-third the length of the basal segment into the front edge of the prostomium, is slightly longer than the prostomium is wide. Basal segments of the antennæ are produced from the lateral lobes of the prostomium, but cut off from them by a well marked suture. They are nearly as long as the tentacle and all three are produced into long filamentous tips. Palpi, thick, fleshy, tapered, finely papillose and ringed near the tip with dark brown. Tips produced to a hair-like point.

*First parapodium* achaetous and directed forward at the side of the prostomium. Ventral cirrus conforming to the dorsal type.

*Second parapodium* with both dorsal and ventral setæ. Notopodium slender, with few dorsal setæ growing out half way between the base and the tip. Neuropodium fleshy, bilobed and long. Ventral cirrus like that on the first foot.

*Third parapodium* nearly typical. Notopodium half as long as neuropodium, three dorsal setæ, neuropodium thicker and longer, ventral cirrus smaller than on second foot.

*Typical parapodium* (Fig. 2). Notopodium, achaetous, slender, rounded at tip and about half as long as neuropodium. Acic-

ula, light brown and slightly curved backwards at tip. Notopodium thick, truncate, bi-lobed, five setæ on nearly every foot, arranged directly underneath one another. Neurocirrus short, globose, produced to a fine filamentous tip.

*Dorsal setæ* (Fig. 1) with notch at tip, serrated on the convex side for a distance equal to twice the width of the spine. As much farther down the concave side is a collar partly surrounding the seta, which then tapers slightly along the shank to the base. These setæ are embedded all but their tips in the flesh of the foot.

*Ventral setæ* (Fig. 4) are very large, strong and sharp, with a few very minute serrations directly under the hook. The chitin is very light in color and almost perfectly transparent. There is almost no fibrous structure in the core of the spine, and this does not extend to the tip.

Dorsum entirely covered with elytra of a dead gray color, which have a single brown spot just above the elytrophore. The surface is otherwise immaculate. They are non-ciliate, reniform, and born on somites 2, 4, 5, 7, —.

The species is described from an example taken July 9, 1915. The figures were made from an example taken the year before which differs from the typical in having the left eyes fused into one. This anomaly is the first one of its kind I have seen. The pigmentation is scattered in small granules over an area corresponding to that occupied by the eyes on the opposite side.

*H. succiniseta* belongs to the type of commensal polynoids, but has itself never been found living with another animal.

The chief reason for calling this a new species is the collar on the dorsal seta.

*Halosydna lagunæ* n. sp.

General aspect like *H. insignis*. Form, oblong-linear, tapering gradually and about equally at both ends. Somites, 26; elytra, 12 pairs on somites 2, 4, 5, 7, —21, 25.

*Proboscis* (fig. 8), constricted in the middle, bulging at base, and flaring at the end, 5 mm. long and 2.7 mm. wide. Papillæ, blunt, conical, arranged 9/9. Jaws of dark brown chitin, produced into a sharp knife edge. Fangs blunt with three prominent ridges on outside face, lower pair biting to the right.

*Prostomium,* about as wide as long, slightly constricted at base, widest slightly behind anterior pair of eyes. No fissure behind the insertion of median tentacle. Eyes, four; anterior pair well forward, further apart, and much larger than posterior pair, which are almost under the lip of the peristomium.

*Antennæ,* dorsal, and peristomal cirri smooth, cylindrical, of moderate length and quite bulbous at tip. Tentacle twice as long as antennæ, and of a similar shape. All tentacles and cirri have dark band just below bulb and another near the middle.

*Peristomial parapodia* small, achætous, composed principally of the ceratophores. Ventral cirrus conforming to the dorsal type.

*Second parapodium* with two fascicles of ventral sectæ, differing from the typical in having a longer spinous section. Dorsal ramus very small, equipped with a half dozen minute slender setæ, smooth sharp and straight.

*Typical parapodia* (fig. 5), distinctly bi-ramous. Neuropodium thickly conical, truncate, fleshy, powerful, wrinkled, carrying two fascicles of ventral setæ. Notopodium thick, short, somewhat rounded at the end, and carrying a flaring bundle of dorsal setæ. Ventral cirrus short, pointed, and subulate.

*Setæ* of four kinds, short dorsal setæ, slender, straight and serrate (Fig. 10); long dorsal setae, strong, straight, sharp, somewhat hastate, but without the least sign of serrations (Fig. 9); superacicular ventral setæ with about ten spinous serrations, most prominent distally, long hooked point and strong shaft (Fig. 6); sub-acicular ventral setæ, of the same type, but serrations distinctly less prominent (Fig. 7).

*Segmental eminences* prominent thruout. Nephridial papillæ, cylindrical and fluted, begin on the eighth segment and continue to the twenty-fifth.

*Elytra,* large, varied in shape from reniform to ovoid. Heavily pigmented with black and brown and have prominent white conical tubercles distributed irregularly over the surface, the larger ones tending to be in the center. Elytra non-ciliate.

*Coloration* white with brown and black pigmentation on the elytra. Some specimens show a distinct reddish tinge. Dorsally there is a prominent intersegmental black spot. Prostomial and

anal region prevailingly brown, but with some black pigment to be seen.

The specimen is very common under mussels and in sea-weed between tide-marks at Laguna. The type was taken under kelp roots, June 28, 1911, by Prof. C. F. Baker. I have many others in the Laguna collection, among which is a tokous female taken June 27, 1914.

(*Contribution from the Zoological Laboratory of Pomona College.*)

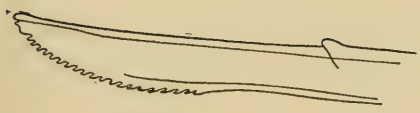
## EXPLANATION OF FIGURES.

PLATE I—*Halosydna succiniseta* n. sp.

Figure 1. Dorsal seta.
Figure 2. Typical parapodium.
Figure 3. Anterior end.
Figure 4. Ventral seta.

PLATE II—*Halosydna lagunae* n sp.

Figure 5. Typical parapodium.
Figure 6. Superacicular ventral seta.
Figure 7. Subacicular ventral seta.
Figure 8. Anterior end.
Figure 9. Long dorsal seta.
Figure 10. Short dorsal seta.



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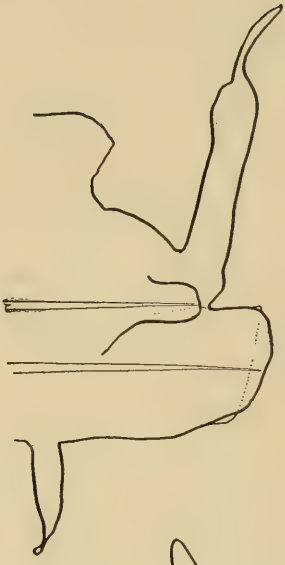

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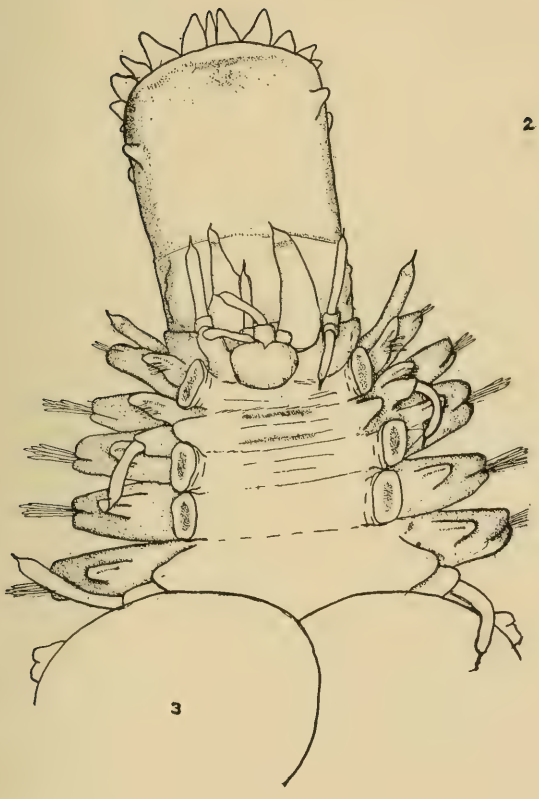

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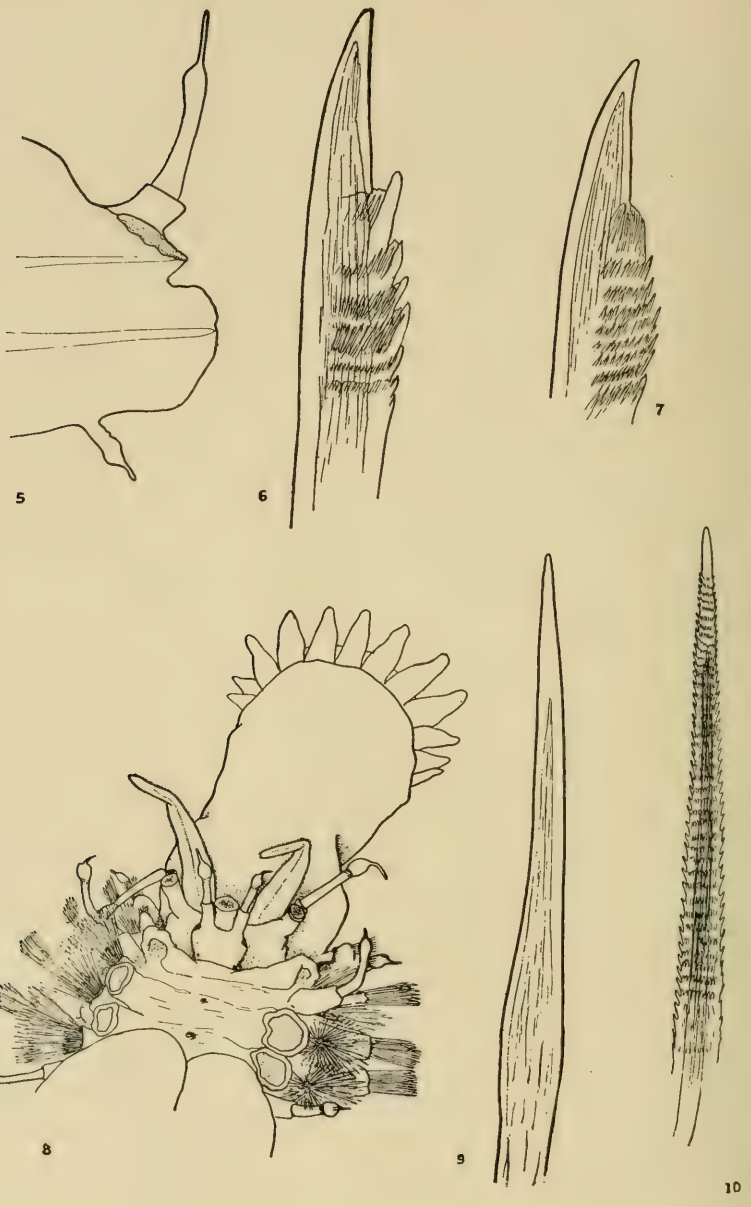
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# The Brown Ctenucha

*Ctenucha brunnea* Stretch

E. O. Essig
University of California, Berkeley, California.

Order—*Lepidoptera* Family—*Syntomidæ*

The moths of the genus *Ctenucha* are exceedingly beautiful and interesting, and inasmuch as little is known regarding the different stages in the development of some of the species the writer has taken this means of recording the main facts in the metamorphosis of one of them. In California there are three common species all very much alike in appearance and probably in habits. Through the aid of my brother, S. H. Essig, I have been able to secure all the stages from the egg to the adult of what I have been calling the brown Ctenucha, *C. brunnea* Stretch. The common name originated from the fact that the upper surfaces of the primary wings of this species are decidedly light-brown in appearance, in contrast to the very dark-brown or almost black wings of the other California species as given in the note below.[1]

## Description

*Eggs* (Fig. 1). The eggs are round, somewhat flattened dorsally, pearly-white when first laid, but gradually becoming deep-yellow just before hatching. They are very small, averaging about 1 mm. in diameter and are laid in short rows of from 2 to 7 or more, either touching at the sides or about the diameter of an egg apart.

*Larvæ* (Fig. 2). The first hatched caterpillars are exceedingly small but very active. They are light, transparently-yellow in color

1. Key to the California species of *Ctenucha*

A. Area between and around eyes brown or black ..... B
Area between and around eyes red ..... *rubroscapus* Ménétriés
B. Front wings light brown ..... *brunnea* Stretch
Front wings very dark brown ..... *multifaria* Walker

*Ctenucha rubroscapus* Ménétriés (Fig. 6). According to Stretch (Zygænidæ and Bombycidæ of N. A., pp. 29-30, 1871-1873) this is a true mountain insect occurring in the Sierras at an altitude of 4,500 ft., frequenting streams. It has been taken in the region of Yosemite Valley. Syn.—*C. ochroscapus* Grote and Robinson; *C. corvina* Boisduval; C. *walsinghami* Hy. Edw. *Ctenucha multifaria* Walker (Fig. 7) is abundant in the lowlands of the San Francisco Bay region.

with many rows of small black spine-areas scattered over the back and sides of the body, each area supporting quite a long light or dark hair. The hairs are longest at the anterior end. The head is amber and the last abdominal segment dusky or faintly bluish. The mature caterpillars vary from about ¾ to 1 inch in length, and are entirely covered with thick, long, buff-colored hairs. There are 2 black tufts on the dorsum of the first abdominal segment and a similar one on the eighth segment. There is a median longitudinal stripe on the dorsum, while the sides and much of the ventral surface are dusky or black. On the dorsum there is a yellow longitudinal stripe on each side of the median black stripe and a yellow stripe on each side of the body in the dark area. The head and prolegs are amber and the front or true legs are black.

*Pupæ* (Fig. 3). The pupæ are dark reddish-brown with indistinct lighter markings. They average about ¾ of an inch in length. Sometimes the cast larval skin remains attached to the posterior end.

*Adults* (Fig. 4). The moths are very pretty, the front wings being of a rich, fairly light-brown above and almost black beneath. The veins often appear darker. The hind wings are dark-brown throughout, as are also the ventral surfaces of the front wings. Both pairs are bordered with white and often show some iridescence. The bodies are beautifully metallic blue or greenish with a bright red stripe on each shoulder. The prothorax and head are of the same red color, with the exception of quite a large black area on the dorsum of the former and a small black spot on the front and one around each eye of the latter. There may also appear two faint black spots on the dorsum of the head between the eyes. The eyes, antennæ and proboscides are black, the latter being half as long as the bodies. The legs are black with white spots at the tips of the femora and tibiæ of the females and large patches of white on the femora, tibiæ and tarsi of the males. The males may be further distinguished by the feathery antennæ and slightly smaller size. The average length of the female body is about ½ inch and the wing expanse about 1¾ inches.

## Life History

Little is known about the life history except in a very general way. The appearance of the moths in the spring and early summer suggests that the winter is passed in the pupal stage. The fact that pupæ are also found in the soil about the bases of the food plants late in the summer also suggests this. The eggs are laid in the late spring and early summer and may be found as late as July. They hatch in a few days, usually within a week, and the young grow very rapidly. Moths of the first brood emerged in July and immediately laid eggs, which hatched within a week, indicating a second fall brood, the pupæ of which probably pass the winter. The larvæ feed upon the blades of the food plant and mature in from 4 to 6 weeks.

## Distribution

This species occurs in the coast region from San Francisco Bay to the southern part of the state. It was first taken on Mt. Tamalpais. All of the specimens studied by the writer were taken at Ventura. The distribution probably conforms to the distribution of the food plant.

## Food Plant

The native and only observed food plant is the California wild rye (*Elymus condensatus* Presl.). The caterpillars feed upon the leaves.[2]

## Natural Enemies

The caterpillars are effectively parasitized by a hymenopterous parasite determined by Mr. H. L. Viereck as a new species of *Protapanteles*. The larvæ of the parasite spin small dark gray cocoons on the body of the caterpillars or on a nearby leaf or stem (Fig. 5). They often emerge from the dead caterpillars in great numbers and were reared in confinement from about 95% of the caterpillars. The parasite is attacked by a hyperparasite (*Hemiteles* sp.) determined and listed as new by Mr. Viereck.

A large *Chalcis* sp. was reared from a pupa.

2. The larvæ of a noctuid moth also feed on the same food plant at Ventura. They burrow into the centers of the stems in which they feed and remain until ready to pupate. They are much more destructive to the host than is the brown Ctenucha.

Fig. 1—*Ctenucha brunnea* Stretch. Eggs laid in characteristic row. Enlarged twice. (Original.)

Fig. 2—*Ctenucha brunnea* Stretch. Lateral and dorsal aspects of the larva. Enlarged twice. (Original.)

Fig. 3—*Ctenucha brunnea* Stretch. Pupæ with cast larval skins still clinging to the posterior ends. Enlarged nearly twice. (Original.)

Fig. 4—*Ctenucha brunnea* Stretch. Dorsal and ventral aspects of the adults. Females at top, males at bottom. Enlarged nearly twice. (Original.)

Fig. 5—Cocoons of a parasite (*Protapanteles* sp.) and dead body of a caterpillar of *Ctenucha brunnea* Stretch. About natural size. (Original.)

Fig. 6—*Ctenucha rubroscapus* Ménétriés. Male, natural size. (Original. Photo by department of scientific illustration, University of California.)

Fig. 7—*Ctenucha multifaria* Walker. Male, natural size. (Original. Photo by department of scientific illustration, University of California.)


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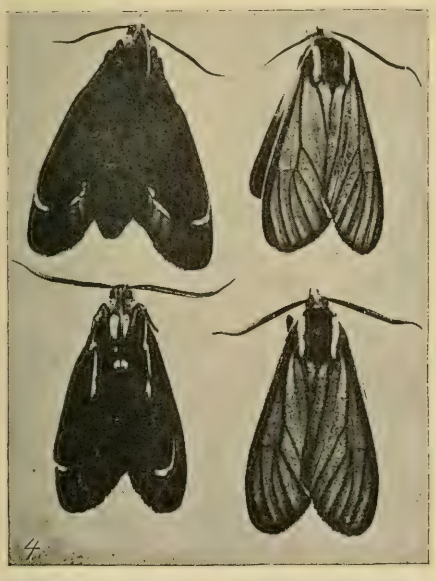
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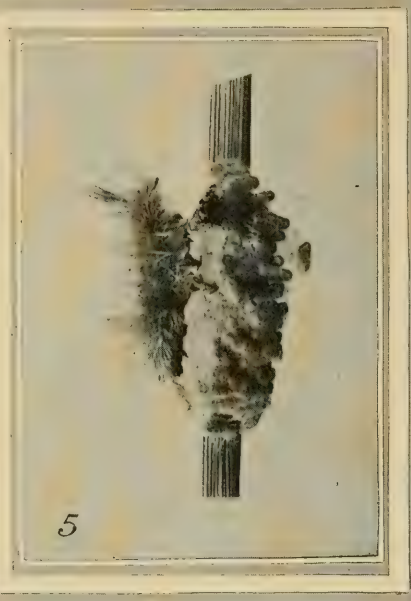
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